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TOPICS OF THE MONTH

Britain's sulphuric acid industry survives a crisis

JUST a year ago we commented in these columns on the improved outlook for the sulphuric acid industry in Britain. At that time there was only one plant actually in commission for producing sulphuric acid from anhydrite on a large scale—that of I.C.I. at Billingham. Now, however, two more big plants are producing sulphuric acid from anhydrite—that of the United Sulphuric Acid Corporation at Widnes and the Solway plant, described in this issue. Now it can truly be said that a radical change has taken place in the pattern of raw material distribution behind the manufacture of sulphuric acid.

Two important trends can be noted. Firstly, the total acid production capacity in Britain has increased since 1951 by over 40%. Secondly, dependence for the manufacture of acid on foreign materials has been moderately, and on American brimstone substantially, reduced during the last few years. That much more sulphuric acid and sulphur could be produced in Britain, at a price, is unquestioned. Reserves of the principal indigenous raw material, anhydrite, at present estimated to be 182 million tons, could provide enough acid for many generations to come at the present rate of consumption.

But, as a recent *Financial Times* article puts it, the principal firms who make acid by roasting sulphur also operate the anhydrite (and pyrites) plants, for a large part of whose output big bulk contracts have been made. What seems probable, therefore, is that a few of the most expensive plants, for the most part the older ones using pyrites, will cease operations before long and that rather more sulphur will be imported.

Record Middle East oil output

BY the end of November, Middle East oil production had already passed the level achieved in the whole of 1954 and, according to recent estimates, the total for 1955 will be over 160 million tons, as compared with 137½ million tons produced in 1954.

Once again the largest individual contribution comes from Kuwait, which was expected to supply 55 million tons in 1955—as against 47,700,000 tons in 1954—based on the recent level of output. In Saudi Arabia, production is likely to be very slightly below last year's figure of 46,900,000 tons. But Iraq, the third largest producer, is estimated to show a rise of some 3 million tons on the 1954 output of 30,700,000 tons.

The greatest individual increase over 1954 figures comes from Persia, where the oil consortium has now been operative for just over a year. Compared with last year's production of 3 million tons, Persian output for 1955 will be of the order of 16 million tons. The remainder of Middle East oil comes from Qatar (estimated at 5½ million tons), Egypt, Bahrain, the Kuwait/Saudi Arabia Neutral Zone and Turkey. In most of these there is likely to be some increase over last year's level of production.

The foregoing estimates are made by the Petroleum Information Bureau, which points out that the rise in Middle East oil supplies—amounting to about 17½% over last year's figures—is the oil industry's response to rising oil demand all over the world. Clearly it is by no means only in Britain that expanding industrial activity has resulted in a rapid growth in oil consumption.

Science and technology in Germany

HAND-IN-HAND with the intensive manufacturing and export activities now being carried on in Western Germany goes an extensive programme of research and development, the proportions of which have not so far been appreciated. Now, however, a report* published by Britain's Department of Scientific and Industrial Research indicates that not only is Western Germany spending enormous sums of money in this direction, but also that, generally, the gap between scientific research abroad and that in Western Germany (and the technological developments flowing from it) is being rapidly narrowed. In some fields, such as electron microscopy, Germany is probably abreast of the rest of the world, if not ahead of it. The traditional engineering industries are again well to the fore; in railway, mechanical and electrical engineering and in building techniques there are already developments of interest to other countries. The chemical industry has put a very large amount of money into research in the last three or four years and has produced significant results in most fields, particularly synthetic fibres, plastics, dyestuffs intermediates, pharmaceuticals and insecticides.

Chemical engineering research is singled out as a subject to which Western Germany has given prompt and effective attention. A research institute has been set up to foster this subject (largely on the initiative of Farbenfabriken Bayer, Leverkusen), and long-term plans have been made for the provision of research institutes each concentrating mainly on specific fields of research. The first institute for this purpose has already been opened at Aachen and is in operation.

Going into some particulars about the various organisations concerned with research in the chemical sciences and technology, the report mentions that the general meetings of the Gesellschaft Deutscher Chemiker (society of German chemists) are attended by anything up to 2,000 persons. Among other important societies is the Deutsche Gesellschaft fur Chemisches Apparatewesen (Dechema), which in the years 1950-52 contributed about DM. 180,000 towards

*'A Brief Review of Science and Technology in Western Germany,' H.M.S.O., 4s.

chemical engineering research in universities and colleges of technology, and is now providing for this purpose something over DM. 80,000 p.a. Amongst the projects that it has supported are fundamental research on heat transfer, mixing and agitation, drying and rectification, conducted at the universities of Bonn and Frankfurt and the colleges of technology of Munich and Karlsruhe.

The impressive recovery of the West German chemical industry has been well publicised and it would be surprising if a great deal of attention was not being given to research and development. All the same, it rather takes one's breath away to learn of the generous scale on which Farbenfabriken Bayer's new laboratories, for instance, are being planned. A hitherto unheard of amount of space will be allotted to each worker and each senior researcher will have a private office opposite his laboratory working space. An interesting feature of the building is the provision of a nitrogen atmosphere between double-walled glass windows to improve insulation and save heating costs.

Dissatisfaction has been expressed in Germany at the steps taken by the universities and colleges of technology to imbue the young engineer or chemist with the new outlook needed to face the implications of automation. A corresponding necessity is the training of skilled workers, such as mechanics and maintenance staff, to handle the measuring and control instruments. The scale on which Germany has adopted automatic control techniques is very much smaller than in the case of the U.S., but the opinion has been expressed in Germany that, in the accuracy and efficiency of control equipment, it is not so far behind.

The whole question of automatic control is being considered from the points of view of energy accounting in view of the relatively high cost of energy in Western Germany. It is being realised that an automatic, steadily operated production plant is very likely to consume a minimum of energy.

These are only a few of the matters mentioned in the report, but the general picture revealed is that of a country which, starting from widespread destruction and chaos, has in ten years regained a position amongst the world's leaders in the scientific and technological fields. It is an impressive achievement.

New rubber reclaiming process

A CHEMICAL process which is said to make possible the production of a new kind of low-cost synthetic rubber, durable and oil-resistant, has been developed in the United States. It is stated that scraps of vulcanised rubber products, containing both natural rubber and the GR-S type of synthetic rubber, have been modified chemically to produce a different rubber, with properties not normally associated with the initial materials.

It has been found that, when vulcanised material and GR-S-type synthetic rubber scraps are reclaimed in the presence of a certain concentration of activated chemical compounds, a definite reaction occurs between the compounds and the rubber. The degree of chemical cross-linking appears to be responsible for the product's oil resistance, a property not normally present in a tyre ' reclaim.'

The process entails mixing ground scrap rubber, reclaiming ingredients and a solid acid—such as citrus acid—in the reclaimator at about 400°F. for about 3 min. The product is cooled immediately to prevent excessive attack by the air, rolled into sheets, and allowed to set at least 24 hr. before use.

According to Mr. J. Green, a research chemist of the U.S. Rubber Reclamation Co., who described the process at an American Chemical Society meeting, the new material is especially suitable for making oil- and chemical-resistant parts, rubber sheeting, rubber-coated fabrics, shoe soles and heels, shock absorbers, wire insulation and structural hard rubber.

Seven years of 'Atomics'

IN embarking this month upon another volume, our associate journal *Atomics* can look back on seven years of pioneering work in the field of atomic information. *Atomics* was the first journal of its kind in Great Britain. Today it is still the only technical atomic journal in this country, although its example has inspired similar journals overseas.

Ever since the days when Harwell was only beginning to look a little different from a deserted airfield, *Atomics* has been supporting and encouraging the development of nuclear energy for peaceful purposes. It has played a significant part in providing a forum for nuclear scientists, and is able to gain satisfaction from looking at the fruits of their work in the form of Risley, Calder Hall, Capenhurst, Windscale, Culcheth and Dounreay, to name only the British achievements.

The recent inaugural meeting of the British Nuclear Energy Conference, reported on another page, marks an important stage in the development of the nuclear energy industry in Britain—an industry which in the comparatively near future, as Sir Christopher Hinton points out, will involve business in the home market amounting to some £300 million a year. *Atomics* may justly be proud of its contribution towards bringing this state of affairs about.

With the firm establishment of the nuclear power programme, *Atomics*, in pursuit of its policy of adapting itself to the needs of the industry, will increasingly deal with all aspects of the nuclear engineering and supply industries, besides publishing, as before, contributions on nuclear theory and other vital aspects of atomic development. Among the subjects to which it will be devoting increasing space are: reactor design; reactor technology; metals, alloys and other constructional materials; reactor control and instrumentation; safety and site selection for reactors; coolant technology; fission products; radioactive wastes and their treatment; radiation problems; radiation laboratories; chemical reaction; chemical separation; chemical engineering, etc.

Atomics thus plans to serve still further its readers in Britain and 50 other countries.

New research laboratories for the Gas Council

BIG new extensions recently opened at the Gas Council's London Research Station, Fulham, add another three laboratories to the station and just about double the floor area available there. Research workers at Fulham are concerned with investigations into the production and purification of fuel gases. In the past few years they have devoted more and more time to chemical engineering and pilot-plant experiments. It is to allow elbow-room for this work that the new accommodation is provided.

The additions bring the number of laboratories to seven. Side-by-side at the station there are a library, stores, workshops, design offices and instrument rooms. Total staff now numbers 100 men and women, working under the direction of Dr. R. H. Griffith, controller of research for the North Thames Gas Board, which administers the station on behalf of the Gas Council.

By far the largest of the new laboratories is a bare, hangar-like building with a floor area of 3,000 sq. ft. Designed to accommodate big pilot plants, especially units of considerable height, it is equipped with a full-span crane capable of handling loads of up to 2 tons.

Access to this section is by a gateway, 10-ft. wide by more than 10-ft. high, sealed by a massive roller-shutter. Work is progressing here on the life of refractory materials used in retorts and on the manufacture of catalyst for organic sulphur removal.

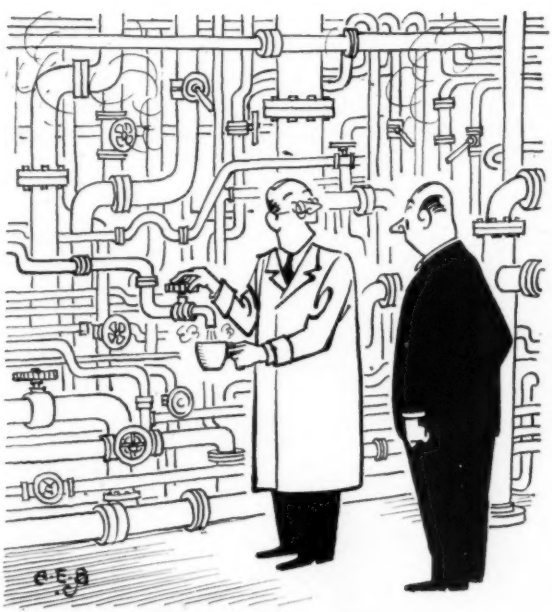
A room in the adjoining block is arranged for smaller pilot-plant experiments. This laboratory houses apparatus used to investigate the biological oxidation of gasworks effluents.

The third of the new laboratories is the fully equipped base of Fulham's mobile team of researchers.

The conduct of research for the gas industry is one of the specific duties of the Gas Council. To fulfil this duty the Council established two research stations —that at Fulham and the other in Birmingham, administered by the West Midlands Board. In addition, all the Area Boards undertake from time to time special items of research at the request of the Gas Council or after consultation with it. Where appropriate, research of interest to the gas industry is pursued jointly with outside organisations.

The Council spent £290,114 on research, testing and development in the year up to last March. Expenditure by the Area Boards totalled £555,000.

Comical Engineering Situations



"THIS ONE'S FOR TEA"

Improved fatty alcohol sulphates

THE fatty alcohol sulphates were among the first textile auxiliaries introduced to take the place of soap in scouring and other wet processing operations where hard water is used. It is necessary to guard against the formation of insoluble lime and magnesia soap scum. The *Gardinols* were about the first products of this type introduced from Germany, together with the *Igepons*, and they initiated a new epoch in the manufacture of textile detergents. Yet, even after so many years, there are still certain problems to be solved concerning the production of sulphonated fatty alcohols and one of these is that of conducting the sulphonation so that the product is both highly sulphonated and free from colour, for to obtain success in this direction is to secure products of greater use to the dyer and finisher.

The straightforward method of sulphonation of a fatty alcohol (this is usually first produced by the catalytic hydrogenation of single or mixed fatty acids obtainable from various vegetable and animal oils, particularly coconut oil) makes use of concentrated sulphuric acid or oleum, but chlorosulphonic acid has also proved very useful. What is required is a sulphonation process which proceeds more smoothly at a reasonably low temperature so that no side reactions or charring occur to give yellowish or brown products difficult to decolorise.

Hence the importance of a recent discovery, reported in *Fibres*, that by using a special reaction product of chlorosulphonic acid and an acid amide such as urea instead of chlorosulphonic acid itself, the sulphonation process can be much facilitated. By this comparatively simple expedient such fatty alcohols as oleyl and sperm oil alcohols (hydroxyl-containing fats such as castor oil may also be used) may be sulphonated at less than 50°C. to give substantially colourless sulphates containing less than 3% of non-sulphonated residues. These residues have wetting, softening, detergent and dye-levelling properties. Urea is the most suitable acid amide to use, since it reacts with chlorosulphonic acid during simple stirring at about 50°C.

Chemical plant opportunities in Austria

AN opportunity for British exporters of chemical plant which may never occur again now exists in Austria. This is the verdict of a mission recently sent to Vienna by the Federation of British Industries and which has now published its report.

With the signing of the Austrian State Treaty in May last year and the evacuation of areas previously controlled by the occupying powers, it was apparent that considerable re-equipment and a further increase in industrial activity might be expected. The F.B.I. therefore consulted its counterpart in Austria (Vereinigung Osterreichischer Industrieller) and decided to send a small mission to Vienna to offer its help in connection with the re-equipment of factories and public services now restored to Austrian control.

Throughout its report, the mission stresses the urgency of more active U.K. participation in Austria's import trade and co-operation with Austrian industry. Austria is now a free country. From what the mission saw and heard, the immediate future offers what is probably a uniquely favourable opportunity for British industry to make its products known to potential buyers in Austria.

That part of the mission's report which deals with chemical plant was compiled by Dr. E. H. T. Hoblyn, M.B.E., director of the British Chemical Plant Manufacturers' Association. Chemical plant opportunities can be assessed by looking at the general structure of Austria's chemical industry, the principal products of which are heavy chemicals and fertilisers. The production of nitrogenous fertilisers was 568,000 tons in 1954, whilst a new superphosphate plant with a capacity of 80,000 tons p.a. was recently put into operation. This is much more than is needed for home consumption; fertilisers, therefore, constitute an important Austrian export and an expansion of production can be anticipated.

Austria is at present self-supporting in sulphuric acid, some 30,000 tons p.a. being made from zinc smelting gases and 40,000 tons by the anhydrite process. There is one calcium carbide plant, the acetylene produced therefrom providing the starting material for the manufacture of chlorinated solvents, including trichlorethylene and perchlorethylene. Calcium carbide production is in the order of 20,000 tons p.a.

Chlorine and caustic soda are produced electrolytically in three plants, the approximate annual output of caustic soda being 50,000 tons. The output of soda ash is about 100,000 tons p.a., a proportion being converted to caustic soda.

Other important products include tar products, pharmaceuticals, penicillin, streptomycin, plastics, rayon, etc.

The report indicates that, while the Austrian chemical industry is not large, it is progressive. Many plants were over-worked during the war years and have had little done to them during the Russian occupation. Equipment is therefore required not only to meet desired expansion, but in many cases for replacement and modernisation. The fields in which there will probably be the greatest opportunities are petrochemicals, fertilisers, tar products, pharmaceuticals, plastics and rayon.

The Austrian chemical industry has been by tradition equipped from Germany, and the German chemical plant industry enjoys such advantages as the common language and weights and measures, and the comparatively short delivery distance in many cases. To compete successfully, the British supplier must put literature and correspondence into German, the metric system must be used and prices should be quoted as ' Free Austrian Frontier.' The Austrian is also attuned to receiving from Germany prompt attention to his needs and good after-sales service; this must be matched by British firms.

It was found that too little was known of the British chemical plant industry and considerable interest was expressed on learning of its achievements and capabilities. It is urged, therefore, that U.K. equipment manufacturers ensure that their prospective customers in Austria are made fully aware of their products.

Novel flowmeter

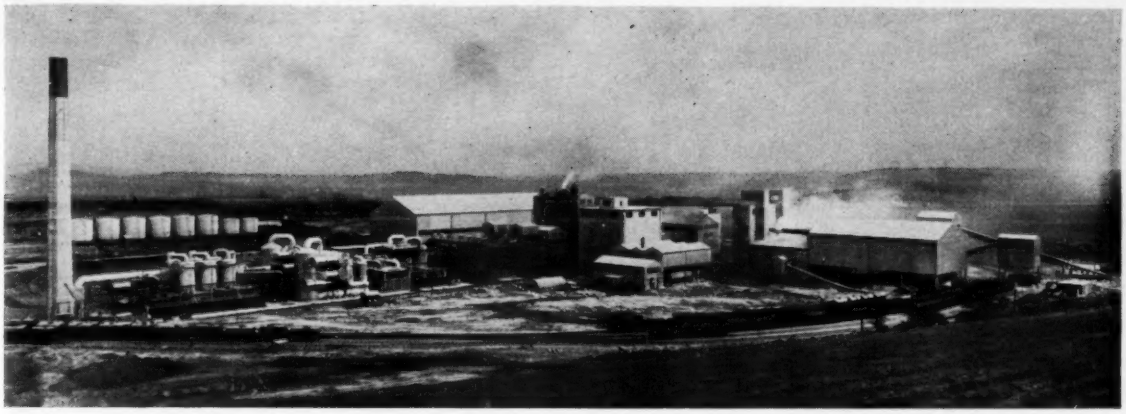
AN ingenious method of measuring electrically the rate of flow of liquids in pipes or conduits is described in the fifth issue of the bulletin of the National Research Development Corporation.

As is customary with some types of flowmeter, a loose body in a pipe is displaced by the flow against a restoring force which increases with the displacement. The novelty of the new invention lies in the fact that the restoring force is applied electro-magnetically.

The pipe used must be of non-magnetic material such as aluminium, glass or plastics. Outside this pipe is a coil through which alternating current is passed. The loose body inside the pipe is of electrically conductive material of low resistivity and is so arranged that eddy currents induced in it tend to repel it against the flow direction. Alternatively, direct current can be used, in which case the loose body may be of non-magnetic material carrying a small permanent magnet. A suitable shape of body is a cup with its opening facing the flow. It must, of course, be light in weight. If a transparent tube is used, the current supply to the coil can be constant, and the values so arranged that the body is forced towards the winding by the fluid flow and will come to rest at some equilibrium position. The pipe can then carry graduation markings which show the rate of flow according to the position of the body.

A neater arrangement is to vary the current in the coil until the body is brought to a fixed point. The current required is registered by a meter which can be calibrated in terms of flow rate. Obviously it is a simple matter to arrange for the current to be increased automatically until the loose body reaches this predetermined point, and with this set-up the tube need not be transparent.

The inventor of the flowmeter is D. I. Lawson, of the Department of Scientific and Industrial Research.



General view of the facilities of Solway Chemicals Ltd. from the north.

The End of the Beginning at WHITEHAVEN

Opening of a New Sulphuric Acid and Cement Plant

The opening of the new £3-million sulphuric acid and cement plant at Whitehaven, Cumberland, marks the fulfilment of the efforts of Marchon Products Ltd., the sponsoring company, to establish a convenient and permanent source of supply of sulphuric acid for its phosphate manufacturing and other activities. It also marks the end of a four-year period of conversion and construction in Britain's sulphuric acid industry, aimed at cutting the country's dependence on imported sulphur and making increased use of indigenous raw materials. Here is the story of the new plant and its background.

THE company which operates the new plant at Whitehaven is Solway Chemicals Ltd., a subsidiary of Marchon. Sulphuric acid and cement are produced from anhydrite and the plant has a capacity for producing 100,000 tons p.a. of each. Anhydrite is provided by Solway's anhydrite mine at Whitehaven; the production target of the mine is in the neighbourhood of 350,000 tons working in one-day shifts only. Sulphuric acid from the Solway plant is used in the nearby Marchon works for the production of phosphates and the manufacture of surface-active agents and detergents.

How it all started

To trace the origin of the Whitehaven project it is first necessary to recall the world sulphur crisis of a few years ago, brought about by the severe cuts in shipments of elemental sulphur from America. British steps to save the nation's economy included a sulphuric acid rationing scheme and a plan for greatly increasing the capacity of the country to manufacture sulphuric acid from anhydrite and pyrites. Since 1951 the country's total acid production has increased by over 40% and, instead of one-half of the total U.K. output of sulphuric acid being derived from elemental sulphur, the figure has been reduced to a third.

The Whitehaven plant forms a substantial part of the capacity that has been added to the British industry. By the time of the sulphur crisis, Marchon had built up, on the Cumberland coast, a large chemical manufacturing organisation which required considerable quantities of sulphuric acid. However, Marchon were geographically isolated from the principal sources of supply, and had in consequence to pay high freight charges on every ton of acid used. A scheme was proposed for the erection of a pyrites plant at Whitehaven, but the Board of Trade was unwilling to give any priority to the construction of a pyrites plant additional to the 20 already under construction elsewhere as part of the general investment plan. There remained only calcium sulphate, found in nature as either gypsum or anhydrite, as a raw material.

Here coincidence stepped in, for the Marchon works was found to be situated above what is probably one of the largest seams of anhydrite in the country. It was decided that the manufacture of acid and cement should be undertaken by Solway Chemicals, in which Marchon Products hold the controlling interest. Anhydrite plants cannot operate on so small a scale as, say, sulphur-burning plants, and the Solway plant was designed to produce about double the normal yearly requirement of the Marchon works.

At this point the Government became interested in the Solway project.

Here, it was realised, were the beginnings of a plant which could make a substantial contribution towards lessening Britain's dependence on imports of American sulphur. Eventually the Treasury agreed to finance a substantial debenture issue. Construction of the plant began at the end of 1952.

Construction work

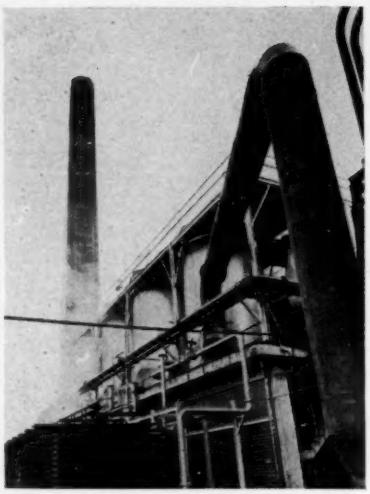
The construction of the plant was not easily accomplished, for the nature of the ground complicated the task. Operations were hampered by the bad weather conditions of 1953-54 which at times reduced the site to a morass of mud. That meant that no small effort was required from the site workers to make up for lost time. Difficulties were tackled and surmounted as they appeared, and the plant was finally completed in the early summer of 1955. Many specialised contractors were employed on the site, working in conjunction with the Marchon engineering department, who acted as principal contractors.

The following figures for quantities of materials used in the construction of the plant may be of interest and give some idea of the magnitude of the task:

Earth and rock moved in site preparation ..	200,000 cu. yd.
Concrete poured ..	25,000 „ „
Structural steelwork used	3,000 tons
Weight of kilns and ancillary gear	1,000 „
Weight of two kiln linings (special fire brick) ..	700 „
Weight of lead used in construction of towers, ducting and pipework	450 „
Weight of packing rings for towers	250 „
Weight of steel in towers, ranks and ducting (excluding mills, crushers, driers and conveyors)	850 „
Length of new drainage dug	5,000 lin. yd.
Length of new railway track laid	2½ miles

Mining and handling anhydrite

The anhydrite mine at Whitehaven is some 300 ft. below ground and the workings are reached by two parallel drifts, each 1,000 yd. long with a slope of 1 in 7. At the working faces, holes are drilled into the rock to receive explosive charges which are then fired by delayed detonators. The loose material (about 70 tons are brought down by each blast) is loaded by electric shovels on to diesel dumpers and tipped into a hopper in the mine, from which it is carried by means of conveyor belts to the screening and crushing system on the surface. The workings are developed on the pillar and stall system, leaving about 40% of the material behind to support the roof. No other support is necessary. Originally it was estimated that the production of anhydrite at Solway would be in the neighbourhood of 175,000 tons p.a., but this figure has been doubled and an average output of 350,000 tons p.a. is expected from the mine, without working more than one shift a day. The increased production is sold for the manufacture of sulphate of ammonia.



Contact plant: absorbers and stack.

From the conveyor belt the anhydrite is taken to the screening and crushing plant, where it is weighed, screened and crushed to a final size of about ¾ in. It is then fed to the raw material silos—five huge, reinforced-concrete structures standing in a row. From there the anhydrite is weighed out on to a belt and fed, together with the other raw materials—shale quarried from the on-site hillside adjoining the plant, and coke which arrives on the site by rail—to a ball mill, where the mixture is ground to a fine powder and pumped to a block of nine raw-meal silos. Here chemical analysis and, if necessary, blending is carried out to ensure that the meal contains exactly the right percentage of raw material constituents necessary for efficient firing in the kilns.

The meal is finally fed to the two rotary kilns, which measure 230 ft. long by 11 ft. 2 in. diameter and are lined to withstand temperatures up to 1,600°C. In normal operation the gas leaving the cold end of each kiln contains about 9% sulphur dioxide and, at the other end, clinker is discharged at a rate of something like 140 tons/day. From here the process divides and becomes two distinct operations.

Acid and cement production

The gases leaving the kiln are passed through an elaborate purifying and cooling system which does not differ in principle from the system used in making sulphuric acid from sulphurous ores, such as iron pyrites. The gas is successively filtered, cooled and dried before being passed over a catalyst with an excess of air so that sulphur trioxide is formed. The sulphur trioxide is then absorbed into circulating sulphuric acid which is kept at a constant strength by the controlled addition of water. The plant is also equipped for the production of oleum. The stripped gas is discharged into the atmosphere through a 200-ft.-high chimney.

The method used in the production of cement at Solway does not differ

Rotary kiln feed building and clinker cooler.

greatly from that used at any other cement manufacturing plant. The clinker discharged from the hot end of the kiln is cooled before storing. It is then left in the storage building to age before crushing, grinding and finally milling. The ground cement is automatically bagged ready for despatch.

Sulphuric acid and oleum are stored in a battery of 1,000-ton tanks, from which they can be fed to road or rail tanks. A pipeline connects the storage tanks with the Marchon works.

Miscellaneous features

The benefits of electricity and automatic control have been fully exploited in the Whitehaven plant, and an 11-kv. ring main system was adopted, with five main sub-stations positioned at the main concentration of load and a further sub-station serving the mine and crushing plant as well as the preparation and handling plant for the raw materials. In the development of the electrical scheme, particular attention had to be given to the effects of acid fumes in the atmosphere and, for this reason, all outdoor transformers were hermetically sealed, as distinct from the more usual practice of providing them with conservators. They were also finished with anti-sulphuric acid paint.

The equipment of the Solway plant includes three automatic dust collectors—two of which are for use in connection with raw meal and cement grinding, each collector serving two mills, while the third is for recovering dust arising from the ventilation of the pneumatically fed blending tanks and silos.

Acid and cement marketing

The principal market for acid produced by the Solway plant is its parent company and next-door neighbour, Marchon Products Ltd. In addition, some half of the plant's output will be available for sale to industry.

Cement is being marketed through the Cement Marketing Co., and for this purpose Solway have signed a long-term contract with the Associated Portland Cement Co. Until recently the north-western industrial area had to rely on supplies from sources 100 miles or more away.

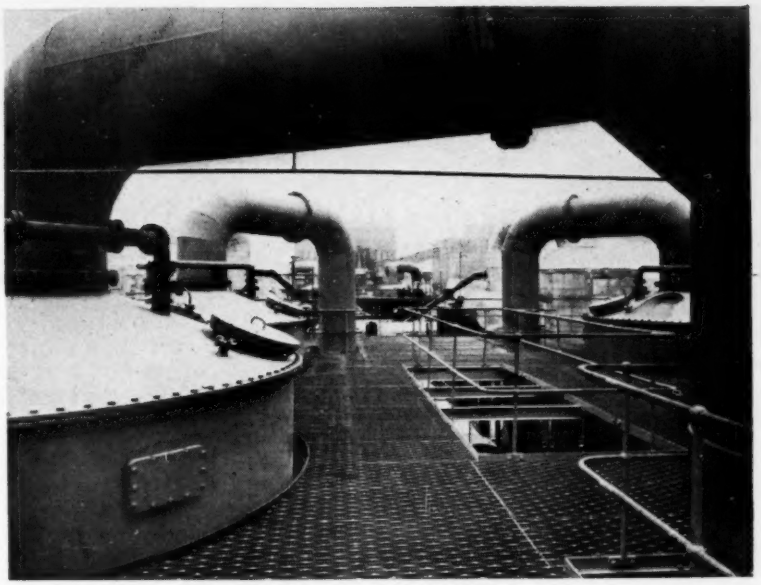
Contractors

The Solway plant was completed by the engineering department of Marchon Products Ltd. as main contractors.

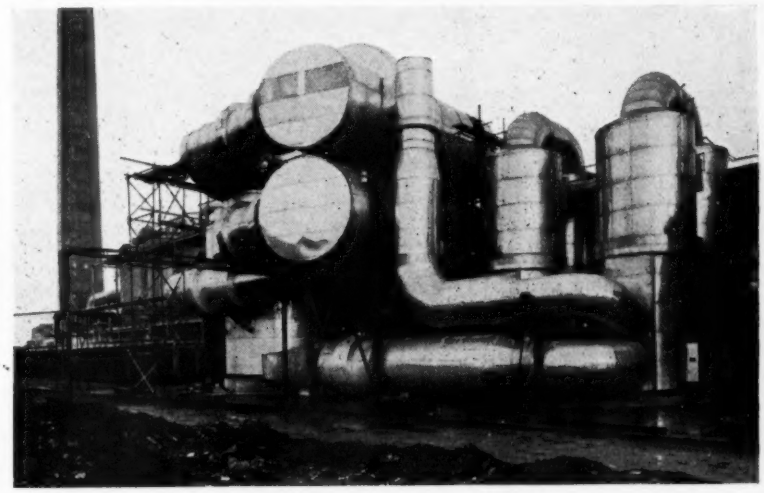
The overall design was supplied by Farbenfabriken Bayer A.G., Leverkusen, who placed at the disposal of Solway their considerable theoretical and practical experience gained over many years of operating the anhydrite process for the manufacture of sulphuric acid and cement.

The plants which Farbenfabriken Bayer A.G. have operated were based on the ' Müller-Kühne ' process, and Solway had the benefit of the advice and assistance of Dr. H. H. Kühne, one of the originators of the process.

A large number of sub-contractors were employed in the erection of the plant, the extensive site work, the sinking and development of the anhydrite mine and the supply of equipment. Some of these are: Edgar Allen & Co. Ltd., Appleton & Howard Ltd., British Insulated Callender's Cables Ltd., British LaBour Pump Co. Ltd., The Cementation Co. Ltd., Constantin (Engineers) Ltd., Crompton Parkinson Ltd., J. Darnley Taylor Ltd., Eimco (Great Britain) Ltd., W. J. Fraser, Hathernware, Holden & Brooke Ltd., George Kent Ltd., Lionweld Ltd., Lockers (Engineering) Ltd., Metropolitan-Vickers Electrical Co. Ltd., Mills Packard, William Openshaw Ltd., Pulsometer Engineering Co. Ltd., Richard Simon & Sons Ltd., Stockdale Engineering Ltd., John Thompson (Dudley) Ltd. and Visco Engineering Co. Ltd.



General view of contact plant from absorber platform, looking back towards kiln.



Heat exchangers and converters (*left*).

Maintenance Problems with Mechanical-Draught Cooling Towers

(Part 2)

By D. J. Tow, B.SC.(ENG.), DIPL.CHEM.ENG.
(Head of Projects Initiation Dept., Head Wrightson Processes Ltd.)

In November, the author dealt with the problems of cooling water treatment and the various types of cooling-tower structure. In this concluding part of this article, he goes on to discuss the inspection and maintenance of the tower packing, distributing system, etc., and also the vital mechanical equipment. Finally he presents a maintenance schedule for mechanical-draught towers and some suggestions concerning their operation in winter.

Packing

THE function of the filling in a cooling tower is to increase the contact between air and water and to maintain proper distribution of both air and water. Its efficiency is affected by oil, dirt, algae and other foreign materials, and it is therefore important that the filling be kept clean. It will be appreciated that a filling composed of flat horizontal slats is more subject to the collection of foreign matter than are decks composed of vertical or sloping slats. Sagging filling tends to cause water starvation at one point and flooding at another. This causes air channelling, because the air will more readily pass through areas of low water concentration than through areas of high water concentration. This air channelling reduces the contact between air and water, thereby reducing the performance.

A number of different types of filling are used in British-built towers. They mainly fall into two classes:

(1) The grid type (splash packing is of this type).
(2) The slotted-lath type (film packing is of this type).

The grid type (Fig. 7) consists of boards or battens nailed upon cleats to form panels. These panels or grids are usually substantial enough to function as scaffoding during the period of erection and are convenient to walk upon when cleaning and inspecting the tower (Fig. 8). In addition, the grids are easily removed and are substantial enough to be cleaned with a fire hose.

The slotted-lath type of filling consists of laths which are slotted and through which are threaded other laths in an interlocked fashion. This type of filling is not nailed and should not be walked upon. Other points to note are that it cannot be readily removed and that it should not be cleaned with a fire hose.

The typical industrial water used for cooling may be expected to contain suspended and dissolved solids in addition to probable traces of oil and sewage effluent. Under these conditions the operational efficiency of the conventional film-type packing, which is, as stated above, of the slotted-lath type, is much reduced for the following reasons:

(*a*) This type of packing depends upon a continuous film on the surface of the wood. The presence of oil in the circulating water causes channelling, which results in less cooling than was designed for.
(*b*) For this reason also the presence of suspended or dissolved solids in the water, which tend to build up a scale on the packing, causes reduced cooling performance.
(*c*) The film-type packing is difficult to inspect and maintain, since the entire packing has to be dismantled to inspect the lower layers of grids. Splash-type packing, however, is open and permits easy entry at all levels for inspection and maintenance.

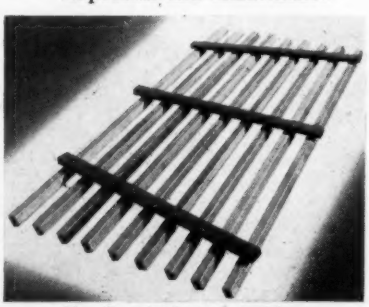


Fig. 7. Grid-type packing.

(*d*) In view of the large timber requirements of the film-type packing, if it is to be at all economical to install it is necessary that the timber laths should be very thin. Bearing in mind the conclusions of the Central Electricity Authority report which have been referred to earlier in this paper, it will be seen that the resulting life of a film-type packing can be considerably less than that of the rugged splash packing.

In some cases oil deposits have been removed from the filling by means of solvents and steam, but it is usually cheaper to replace the filling.

Algae growth is a major cause of reduced performance of cooling towers and, once algae has gained a foothold, there is little that can be done but to shut down the tower. A thorough cleaning can usually be accomplished by means of a firehose, as mentioned above, and/or circulating a strong chemical solution. Whichever method is used should be followed by a flushing and draining of the entire cooling system to prevent the fouling of the heat-exchange surface by the dead algae.

Drift eliminators

As the warm air passes up through the tower it is heavily laden with water. This water must be removed with the minimum impedance to the flow of air upward. The best and most efficient type of drift eliminator is the two-pass or 'zig-zag' type (Fig. 9). Their efficiency is also affected by dirt, algae, chemical salts, etc., and they should be periodically cleaned.

Drift eliminators operate in a moist, warm atmosphere and occasionally are attacked by fungus.

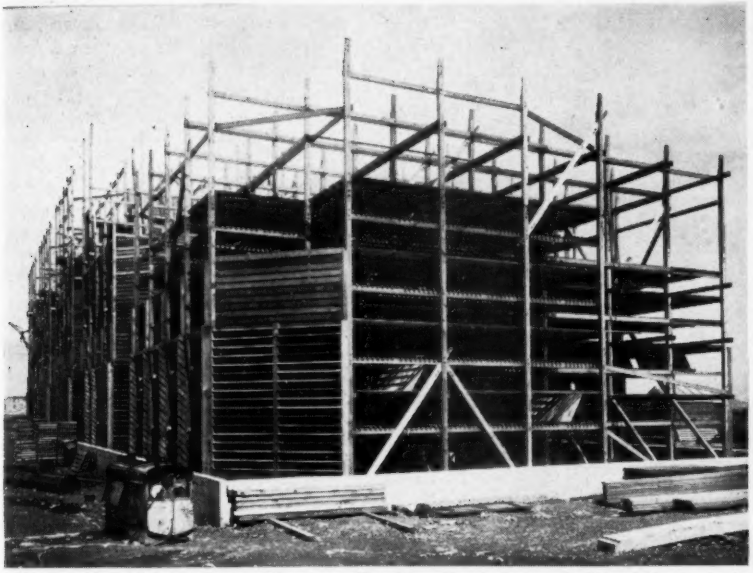


Fig. 8. Erection photograph of cooling-tower structure designed for evenly distributed load and showing grid decks in position used for construction.

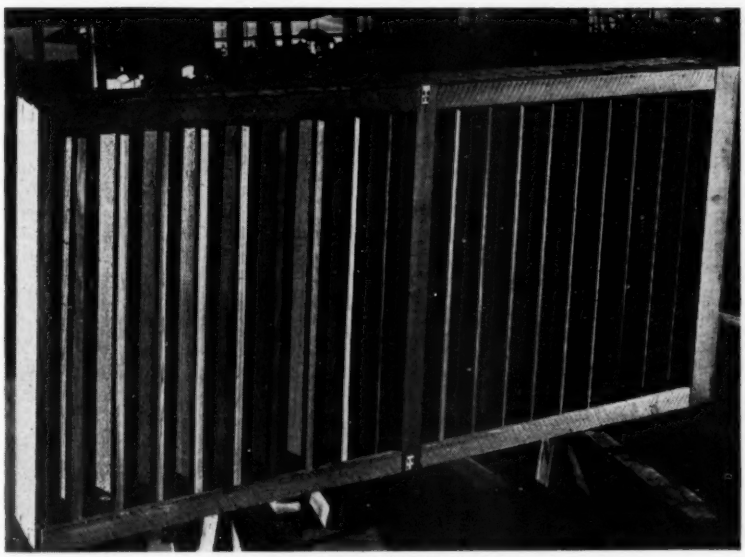


Fig. 9. Zig-zag drift eliminators.

Distributing system

It is very important that the distributing system should be maintained at peak efficiency. The function of the distributing system is to distribute the water uniformly over the top of the tower and to break it up into fine particles in order to expose as much water surface as possible to the air.

There are three main categories of distributing systems in use today; two are totally enclosed (Fig. 10), while the third is of the open type. The three categories are (1) the upspray, (2) the downspray and (3) two kinds of open systems. Note that whatever type of system is employed on new towers, it will be necessary to inspect the nozzles every week or two for the first three months of operation. This is to make sure that wood splinters, shavings or other debris normally found in a new tower have not plugged some of the nozzles.

Upspray system. This consists of a central header with pipe sidearms to which, at regular intervals, are attached the upspray nozzles (Fig. 11). This system operates at approximately 5 to 6 lb. nozzle pressure, and depends on centrifugal force rather than small orifices for fine break-up of the water. The nozzle orifices are usually about 1 in. in diameter. This large opening, together with the prescribed pressure drop, is sufficient to prevent algae, dirt or sand from plugging the nozzles. The system is usually located about 6 or 8 ft. below the drift eliminators on mechanical-draught towers and the nozzles spray upwards and completely fill the spray chamber with finely divided water. This type of system will distribute the water uniformly, with a wide variation of water flow, and requires a minimum of attention, but should be inspected every 9 to 12 months when any obstructions in the nozzle can be removed. This inspection, of course, is dependent upon the fact that the system has been inspected as mentioned above during the first two or three months of operation.

Downspray system. Here there is a central header with pipe sidearms to which, at regular intervals, are attached downspray nozzles. This system is usually located as close to the top of the tower as possible and operates on about 1½ lb. nozzle pressure. Because of the low pressure, the nozzle must operate on the principle that water impinging on a plate will be distributed evenly (Fig. 12). This system will not keep itself quite as clean as the upspray system; however, it will uniformly distribute water with a wide variation of water flow. This system should be inspected every three to six months.

'Open'-type system. This is composed of a main trough extending throughout the top of the cell with interconnecting side channels. This system is usually constructed of wood. In the bottom of the channels, holes are usually bored, and into these are inserted plastic discharge tubes. Some 2 to 3 ft. directly below each discharge tube is a plastic splash plate upon which the discharge stream from the channels impinges. The effect of the stream of water falling on this plate causes a splashing action which distributes the water. The system is not as flexible as the two types previously described, and at high water rates the channels overflow, and at reduced water rates the water is not uniformly distributed.

A continual maintenance problem is presented because the channels tend to open up at the seams and they require levelling. The splash plates have to be renewed periodically, as well as adjusted so that the stream of water impinges directly on the centre

of the disc. The channels require frequent cleaning because they form an ideal place for sludge and sand to accumulate. Algae growth varies with the water temperature and the channels therefore handling hot water offer an ideal place for its growth. This type of system should be inspected every month.

There is an alternative type of 'open' distribution system which covers the effective part of the cooling-tower roof. This type is not very common in Britain, but should be mentioned to complete the picture. Here a large number of small nozzles operating at an extremely low water head are used. These easily become plugged with small debris, and this type is also susceptible to increased algae growth, due to the hot water temperature and to its exposure to direct sunlight. By placing a cover over the distributing system, much of the debris blown in by the wind can be eliminated. This will also retard algae growth, since it shields the water from direct contact with sunlight. Without covers the system should be inspected every month. If covers are provided, inspection should be made every two to three months.

If the distribution system is allowed to fall into a state of disrepair, the performance of the tower will be seriously affected and repair costs increased.

Basins

Cooling-tower basins are usually constructed of concrete, although in certain cases they are made of wood or steel. Occasionally the water circulated in the tower will have a detrimental effect on the concrete basin and, in such cases, it has helped to cover the basin with an asphaltic-base material.

When cooling-tower basins are constructed of wood, it is difficult to maintain a watertight basin. This is particularly true when a tower is used seasonally, such as in connection with an air-conditioning system. A wood basin should never be allowed to dry out, because a change in moisture content of the wood causes a change in its dimensions. If wood is allowed to dry and shrink and then to soak and swell, it will be found that the wood will never quite revert to its former dimension. Therefore, if this wet and dry cycle is repeated very many times, it will be found that the basin will no longer be watertight.

Suction-pit screens should be incorporated in all cooling-tower basins. They strain extraneous matter from

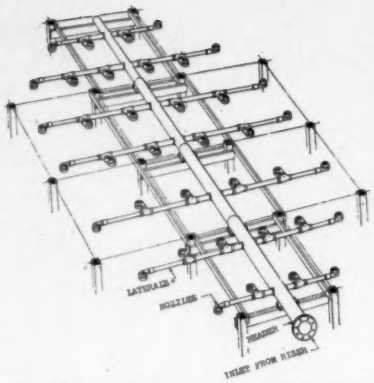


Fig. 10. Totally enclosed distribution system.

the cooling system and do much to reduce the maintenance of the circulation system.

The water level in the basin should always be kept above the level of the anchor bolts and anchor castings. Inspection has shown that the interfacial surface between the air and water is very corrosive, and that very little corrosion occurs above or below this face.

MECHANICAL EQUIPMENT

It will be obvious that the successful operation of mechanical-draught cooling towers depends upon the efficiency of the mechanical equipment (Fig. 13), and thus it is important to prevent the failure of any part of this equipment, such as the fan, gears, coupling and shaft, by adopting a regular maintenance and inspection programme.

A recent development is the inclusion of a safety switch, which provides a positive safety device both from the standpoint of tower damage and personnel protection (Fig. 14). Should excessive vibration accidentally occur, the safety switch immediately cuts off the power, thus preventing damage to the tower or mechanical equipment. The switch is located outside the fan ring and is connected to the motor energising circuit. In the case of sudden vibration, the ball which is balanced within the switch becomes dislodged. This immediately cuts off energy to the fan driver.

Gears

The standard gearbox is unsuitable for use in a mechanical-draught cooling tower and a series of boxes designed specifically for this application have been developed. Fan-cooled boxes should not, of course, be used, since they introduce a cross-flow of air which tends to encourage turbulence and recirculation, resulting in lowered efficiencies of the cooling-tower fan. Consequently, the gearboxes must have more careful provision made for heat dissipation than one would require when transmitting the same power under normal circumstances. The gearboxes should be generously sized and special provision made to ensure that the breathing of the gearbox caused by heating and cooling during operation does not result in the entry of water vapour into the box. Gearboxes should therefore be provided with a breather pipe which allows the expansion and contraction of the air in the box to be communicated to the clean, dry atmosphere outside the cooling tower. In this manner, water vapour is not sucked into the box and the corrosion danger is eliminated.

The most popular type of gearbox in operation in British-built towers is the single-reduction worm type which transmits power from a horizontal electric motor to a vertical fan. The tower fan is mounted directly on the vertical output shaft. These gear units should be designed for continuous duty in cooling-tower service. Care should be exercised during the mounting and alignment of the worm gear, since the life of any machine is dependent to a large extent on the manner in which it is installed.

The foundation must be level and flat to provide even bearing for all the feet. If a flat machine surface is not used, the base must be carefully skimmed to equalise the load and to level the unit. Failure to do this will cause the housing to distort when the foundation bolts are tightened, which will result in misalignment and uneven loading conditions. This could easily result in straining the housing and seriously overloading some parts of the gear unit. The foundation must also be sufficiently rigid to prevent deflections either from the weight of the unit or from the transmitted load. Any such deflection would result in misalignment and uneven loading conditions, with a consequent danger of seriously overloading some parts of the gear drive. The gear unit must be accurately aligned with the drive motor.

The unit must not be operated for a prolonged period with the original lubricant. Before putting into normal service, the unit should be operated for about five days and then drained and refilled with the type of lubricant indicated.

The oil level in the gear should be checked every month. If it is found that the level has gone down, the case and oil seals should be checked for

leaks. If, however, the oil level has risen, drain a small sample from the bottom of the gear case and check for contamination and emulsification. Because the gear on an induced-draught cooling tower is located in a hot, humid air stream, condensation of moisture may occur in the gear case. This is particularly true in towers which are operated intermittently. Should there be any signs of emulsification, the oil should be drained and refilled with the type of lubricant recommended by the manufacturer. Twin oil seals are usually provided specially to prevent ingress of water into the box and these seals should be checked if it is considered water has entered.

An oil sample should be drained from the bottom of the gear case every three months and, if the oil shows any sign of emulsification, deterioration or contamination it should be drained and refilled. Most certainly the oil should be drained and refilled every six months with the lubricant recommended by the manufacturer. Once a year the oil seals should be checked and also the bearings. The fan shaft bearings usually have the greatest wear and can be checked by rocking the fan blade up and down. Some gearbox designs do not allow sufficient sump capacity for collecting water and sludge below the lower main bearing. This point should be watched. In some cases a length of pipe is provided which is suitable for draining the water and sludge away.

Couplings

The floating shaft couplings used on cooling towers fall into four classes:

(1) Gear types.
(2) Metal-disc types.
(3) Universal-joint types.
(4) Rubber bush types.

The gear-type coupling should be taken apart and inspected once a year. The lubricant, plus any contamination, should be drained and discarded and the teeth on the coupling washed with kerosene and examined for wear before reassembling. Because of the possibility of water ingress caused by the centrifugal action of the revolving coupling, great care should be taken to ensure that the lubricant used is of a waterproof type whose specific gravity is greater than that of water.

The metal-disc-type coupling should be examined every six months for cracks and breaks in the fabric or metal discs. Should they show any signs of wear the discs should be immediately replaced.

The universal-joint-type coupling requires lubrication every three to four weeks. This type of coupling requires a heavy oil rather than a grease.

The rubber bush-type coupling, which is the most favoured in British-built cooling towers, should be checked every six months for proper alignment. This coupling must not be considered as a universal coupling capable of accommodating obvious misalignment in initial assembly. The input flexible coupling provides protection against misalignment and the initial alignment must be made with the same degree of accuracy as would be required with a rigid coupling. The input-shaft coupling must be of push fit or light, dry fit on the input shaft of the gear unit, and excessively heavy interference fit cannot be used, as damage to the shaft bearing will result from driving the coupling on to the shaft.

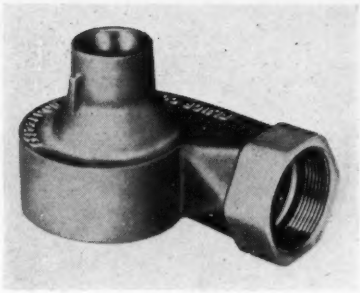


Fig. 11. Spirodome nozzle.

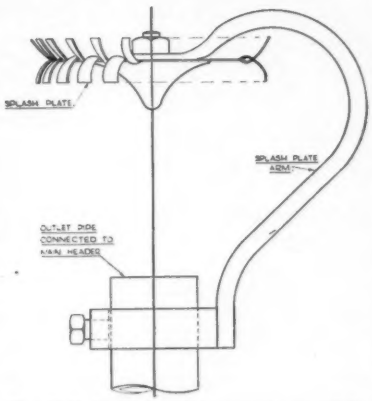


Fig. 12. Splash plate (downspray nozzle).

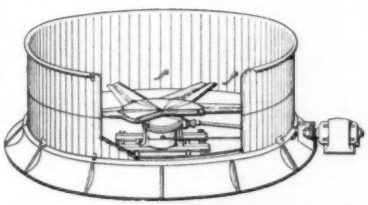


Fig. 13. Induced-draught cooling-tower mechanical equipment: fan, gears, coupling and motor.

Fans

The fans used should be of the axial-flow type with a large central spinner to stop recirculation of air.

The three classes of fan blades used on cooling towers are:

(1) Fabricated mild or stainless steel.
(2) Cast aluminium.
(3) Aeroplane wing section.

Once a year the fan blades should be examined for cracks caused by fatigue. The stainless-steel fan should require little or no maintenance, while the carbon-steel and aluminium fan blades may be scraped and coated each year or two with a preserving material, *i.e.* zinc sprayed and painted. Both carbon-steel and aluminium fans have been known to give many years' service without blade maintenance being necessary. The aeroplane-wing-section type consists of struts covered with metal or fabric. This type is very prone to damage and should be examined every three months or so for tears or rips in the covering. If this occurs, repairs should be made immediately, otherwise the entire fan can be destroyed. A fan will usually become sufficiently unbalanced in normal service to require rebalancing every three or four years. This is caused by the uneven erosion, corrosion or deposition on the blades. The two types of vibration which emanate from mechanical equipment are easily distinguishable. The vibration of an unbalanced fan will give a swaying motion to the tower because of its relatively great mass and slow speed, while the misalignment of the motors and gears will cause a high-speed vibration which makes a rapping sound.

Motors

The electric motors specified should be of the totally enclosed fan-cooled type. In cases where the winter cooling load is equal or less than the summer load, it is generally desirable to provide two-speed motors. It should be noted here that the 'load' of a cooling tower depends upon the wet-bulb temperature and thus the power can be reduced either when the water quantity is reduced or when the wet-bulb temperature drops, giving a greater temperature difference between the cold-water temperature and the wet bulb. Such two-speed motors can be operated at half speed during the winter months at the expenditure of only approximately one-eighth of the full power load. British manufacturers supply completely adequate motors which, of course, are mounted outside the fan stack and from which

the power is transmitted to the gearbox through the coupling and floating shaft.

MAINTENANCE SCHEDULE

In conclusion, a maintenance schedule recommended for mechanical-draught cooling towers is given below, followed by recommendations regarding the operation of towers in the winter.

Once per week:
(1) Inspect suction pit screens and clean as required.
(2) Run idle units for 10 min.

Once per month:
(1) Check oil in gear case for level and contamination.
(2) Lubricate universal-joint-type couplings.
(3) Inspect and clean 'open'-type distribution systems.

Once every two months:
Check motor bearings and lubricate if necessary.

Once every three months:
(1) Check downspray distribution system and clean if necessary.
(2) Inspect disc-type couplings for fractures in discs.

Once every six months:
(1) Drain and refill gear case with recommended oil.
(2) Check rubber bush-type coupling and its alignment.
(3) Check upspray distribution systems.
(4) Check all steel parts of fan support assembly; fan rings and guards should be repainted where necessary. Check and tighten where necessary all fan stack bolts and rods, also bolts for bolting down motor and gear to supporting members.

Once every year:
The tower should be shut down and thoroughly cleaned from top to bottom, including the basin. A thorough inspection of the structure should be made, together with the necessary repairs and replacements. Should the tower contain an 'open'-type distribution system, it should be re-levelled and repaired at this time. The mechanical equipment should be checked for alignment and the bolts anchoring this equipment to the tower should be tightened. The fans should be inspected and repaired if necessary. The gear-type couplings should be opened up for inspection and services and the gearbox bearings and seals examined for wear.

Most cooling-tower manufacturers operate an inspection and maintenance service and should be asked to inspect your tower once a year to ensure it operates at peak efficiency.

Operation of mechanical tower in winter

Cooling towers being operated during freezing weather should receive frequent inspection until the operator determines the easiest method for control at ice conditions. Ice most frequently forms on louvres, but sometimes builds up on decks and fan assemblies. The temperature of the circulating water should be maintained as high as practical for operation. This may be accomplished by one of the following accepted practices:

(*a*) Shut fans down to half speed or off as required.
(*b*) Shut back on water flow with proper reduction of cells and fans as required.
(*c*) Shut back on number of cells in operation, with increase in water flow over remaining cells.

For removal of ice already on louvres and lower decks, the fans may be shut off one at a time for short periods to flood iced area with warm vapours. Electrical switching gear may also be installed so that fans may be reversed for short periods of time to blow warm air across louvres.

Care should be taken when starting up fans in freezing weather, for ice and snow may have formed on the fan sections, causing severe unbalance.

Exposed piping and water basins should be drained on prolonged shut-down periods during freezing weather.

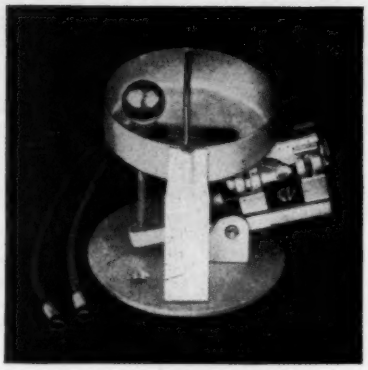


Fig. 14. Safety switch.

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.

Maintenance of Stainless Steel Apparatus

Recent years have seen an increasing tendency in the chemical industry to use stainless steel for apparatus which was formerly made of more expensive alloys. Not all attempts which have been made in this direction have been successful, and some firms were very disappointed to find that the 'corrosion-resisting' steel they had used did corrode. This was pointed out recently in a paper presented to the Chemical Engineering Section of the French Institute of Industrial Chemistry. In fact, it is stated, only one particular type of corrosion, the so-called intercrystalline corrosion, can be excluded by the simple choice of the right type of steel, *e.g.* a steel of austenitic structure containing 18% chromium, 10% nickel and less than 0.04% carbon.

But there are other types of corrosion, such as the one produced by solutions containing chlorides, which cannot be completely excluded, although additions of molybdenum and copper to the steel will reduce it to some extent. Other causes of corrosion are to be found in the places where the steel comes into contact with other materials—not necessarily other metals.

To keep these types of corrosion to a minimum much can be done by the chemical engineer in charge of the maintenance of the apparatus. Monsieur M. L. Guitton, manager of the stainless-steel service department of Sociétés Ugine, who presented the paper referred to, offers the following advice, based on many years of experience with this particular problem:

The apparatus should be cleaned periodically with hot water and a nylon brush. Hot water alone is not sufficient, and a steel brush should not be used under any circumstances.

Those parts of the apparatus where corrosion is most likely to occur should be passivated from time to time. If corrosion occurs nevertheless, the corroded metal must be immediately removed and replaced.

The apparatus should never be in contact with a liquid longer than necessary, even if the liquid is only water.

When the apparatus has been emptied, it should be rinsed very carefully with water, and particular attention should be paid to the outlet tubes, which might corrode more easily than the apparatus itself because they are only used from time to time.

The outside of the apparatus should also be kept clean by means of hot water and brushing.

FILTRATION

Part 2.—Equipment and Applications

By H. K. Suttle, A.M.I.CHEM.E., F.R.I.C., M.INST.F.

(*Department of Chemical Engineering, Loughborough College of Technology*)

PERHAPS the most complete account which has appeared during the period under review is that by R. Berline[27] in a paper presented at a conference held at the Centre de Perfectionnement Technique. This paper reviews and focuses attention on the question of continuous or intermittent filtration with automatic cake removal. Dealing with continuous filters, the author draws attention to the reappearance on the market of a unit similar to the drainage table, known for more than 40 years. The principle is that of a disc, composed of a number of filter segments, which slowly rotates on a vertical axis. At the appropriate point, a segment rotates above a cell into which air is blown for the release of the cake. The cake is removed by a 'knife,' arranged as a section of a helix, which is made to come into contact with the rotating filter bed and so act as a discharge guide.

Another ingenious unit described is a filter arranged as a series of tipping hoppers. The filter units are segments of a circle, rotation takes place in a horizontal plane (*i.e.* the axis of the 'wheel' is vertical) and at a chosen position in the circuit one of the hoppers is given a see-saw, or tipping, motion by which the cake is discharged. There follows a description of a continuous drum filter operated under pressure.

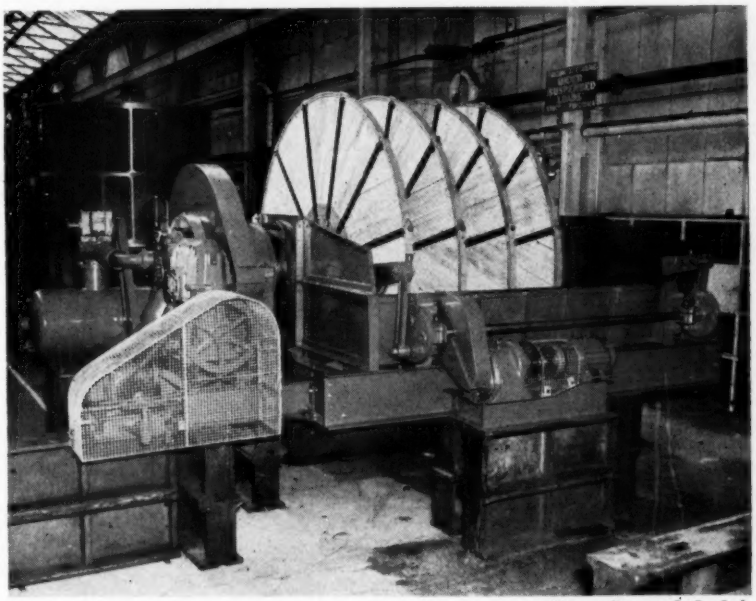
A continuous-band filter operating by means of vacuum is described and its use discussed. It is at present in use for the separation of phosphoric acid from gypsum, where the cake produced is of even thickness of about 10 cm. It is suggested that this unit may be adapted to washing and to the extraction of solubles.

An automatic, continuous, candle filter unit is described in which compressed air is used. The most important applications of this machine appear to be two only at present, namely (1) the filtration of untreated river water for the removal of particulate matter larger than 12 microns and (2) the purification of ammoniacal liquor at coke oven plants by the removal of tarry material which would otherwise interfere in the operation of subsequent distillation and recovery processes.

Intermittent filters with automatic cleaning devices are next described and include a porous stone filter, a pressure filter consisting of rotating discs and a vertical pressure filter provided with hydraulic cleaning discharge. The rotating-disc filter is of special interest, as the filtration efficiency is controlled by an infra-red ray signal device which, in turn, operates an acoustic warning signal. When the warning signal is sounded the fraction of the filtration circuit which has failed is automatically put out of action, whilst the remainder of the filtering surface continues to function. It is not surprising to learn that this filter has met with the greatest success in the largest sugar refinery in Europe, where only five of these units deal with the filtration of the juice after the first carbonation process.

'Burwell' filter

The writer is indebted to Prof. Dahlstrom for a copy of a paper presented jointly with R. B. Thompson[28, 29] on the Eimco *Burwell* filter. This unit is really a mechanised plate-and-frame filter which has achieved considerable success in the treatment of tungsten leach residue containing some 50% solids. This is a particularly difficult pulp to treat, the liquor containing 60 to 100 g./l. of WO_3 and 10% Na_2CO_3, and sparkling filtrate is required. Such a residue from a leaching process is always of small particle size and, in this case, the solids are found to be 75% through 325 mesh (.043 mm.). It is true that the filter



[*Davey, Paxman & Co. Ltd.*

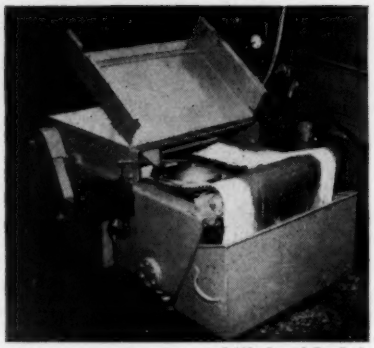
A rotary-disc filter designed for the continuous dewatering of flocculated or froth-floated coal slurry. The filter is of the *Acco* type; the makers state that a special feature of this type of vacuum filter is its flexibility of performance. This is achieved by providing for additional filter discs to be added to the standardised centre-tube section as and when required. If production of slurry is at a lower rate it is a simple matter to remove any surplus discs and to operate the filter at the required lower capacity.

press can be made to produce the clearest filtrate either by using precoat or by circulation until the desired filtrate is secured, but the problems involved in handling and dismantling are sometimes of such importance that other, and continuous, methods are sought. The filter described on this occasion combines the desirable features of the normal filter press (with its plates and frames) with extreme rapidity in cleaning. Less than 5 min./cycle is claimed for the change of the frames. The frames are circular in section and two sets are mounted at 180° to each other on a shaft which can be conveniently rotated, while feed, wash water and air blow are arranged through suitable headers. After sealing of one set of plates the operation is commenced; meanwhile, the other set is held in the 'ready' position. As soon as the cake has formed and washing is completed, the cake-laden frames are rotated through 180° by means of a motor. This operation results in the automatic positioning of the other set of plates, and filtration recommences immediately. The Salt Lake Tungsten Co. estimates that by installing this type of filter it has increased its filtration capacity per sq. ft. of filtration area by 1,700%. In addition, very large reductions have been secured in labour, loss of solubles, wash water required and filter media required.

Other filter developments

Continuous disc filters are being increasingly used for the treatment of fine coal and slimes. A very detailed account is given by Silverblatt and Dahlstrom[30] on the underlying theory and modern practice in this field. Useful flowsheets are presented and details of test runs are analysed. In addition, pretreatment of the slurries is discussed and an example is given to indicate the equipment and performance for a particular case.

The operation and use of a continuous-pressure filtration unit for the treatment of the hot-water extract of Irish moss is described in a paper presented by Dahlstrom *et al.*[31] The process is a difficult one to operate in the usual manner because of the rapid falling away of the filtration rate as the cake of colloidal material is built up. For this reason, pressure filtration is suggested and the Eimco continuous-pressure drum filter is described. *Orlon* fabric is the suggested filter medium or, alternatively, *Monel* screen if the operation is conducted at a high temperature. The proposed flowsheet is given. An earlier paper by Nickolaus and Dahlstrom[32] describes in considerable detail the operation of this continuous-pressure filter together with the theory underlying its use.



[Alfa-Laval Co. Ltd.

A continuous fabric filter which is manufactured in three sizes, having nominal capacities of 10, 15 and 30 gal./min., depending on the viscosity of the liquid being filtered, degree of contamination, etc. The liquid to be filtered is delivered by pump or gravity to the unit, which comprises a wire-mesh conveyor having on its surface a layer of specially bonded fabric. The solids are retained on the surface of the fabric, the filtered liquid passing through to drop into a sump, from which it is drawn by a pump. When the accumulated dirt layer slows up the rate of flow through the fabric, the level rises, lifting a float which operates a switch controlling the conveyor motor. The conveyor then slowly moves along to deposit the dirt-laden fabric into a container and presents a fresh area of clean fabric to enable filtration to proceed.

String-discharge rotary vacuum filters are becoming increasingly popular in Britain. A well-known American machine is now being manufactured in this country.[33]

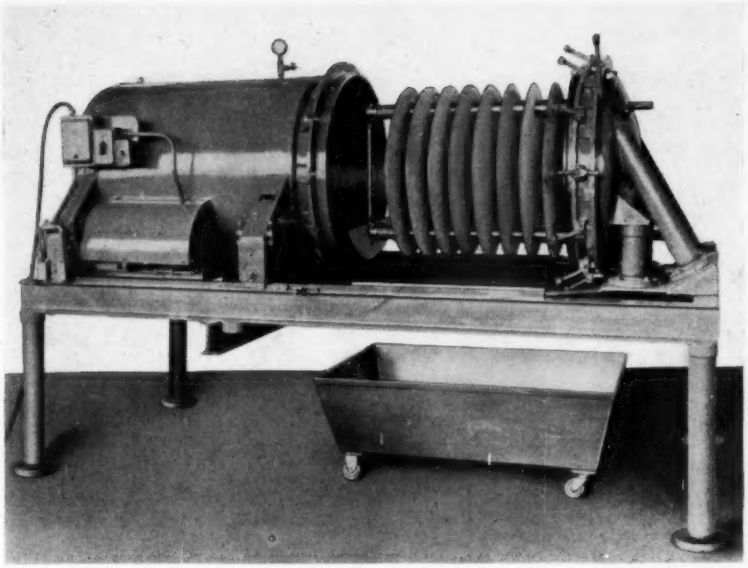
Filter media and ancillaries

The more novel features are perhaps to be found in the treatment of gases. A moving coke-bed gas filter described by Egleson *et al.*[34] is devised for the removal of entrained dust found in the gas streams of synthesis gas plants. The operation is simple, yet ingenious. Fine coke is slowly moved downwards through a tower up which the gases are flowing. The bottom layer of coke is quickly fouled and is continuously removed to a hopper where it is washed free from adherent dust and then returned to the beginning of the coke circuit. In the course of experimental runs in which coke particles varying in diameter from 0.09 to 0.4 in. were used, efficiencies of dust removed varied from 96.4 to 99.8%, according to the conditions of experiment. It was found that the efficiency of the filter is improved by using a water spray at the top of the bed.

In contrast to this paper, the recovery of soluble gas and aerosols from air streams is discussed by Berly *et al.*[35] It is of special interest to the chemical engineer as it is concerned particularly with the removal of HF from the waste gases found in the stack gases of metallurgical processes. After a review of conventional methods (ceramic packings and alkali absorbent) an account is given of experimental work designed to investigate the efficiency of fibre packings. The packings used for HF were made of *Saran* (thermoplastic vinylidene chloride) and *Dynel* (vinyl chloride-acrylonitrile copolymer) which are not attacked by this reagent. Other test aerosols were ammonium bifluoride, sulphuric acid, aluminium chloride, atmospheric dust, talc and silica. Glass-fibre packs, and also cotton cloths, were also used as appropriate. Although the emphasis in this paper is on the absorption of soluble and reactive gases, when considered as methods for the removal of mists, fumes and dusts alone, the efficiency is very high.

The final report on a research programme at the Hanford Atomic Products Operation into the filtration of radioactive aerosols by glass fibres is presented by Blasewitz and Judson.[36] The object of the investigation was to devise a method for the removal of submicron size radioactive particulate matter from process-cell ventilation systems, which would be an improvement on the methods used hitherto. The radioactive aerosols have a mean particle diameter in the range 0.2 to 0.7 micron and this material had been removed previously, at an efficiency of the order of 99.7%, by means of sand filters built up of successive gradations of sand placed in large underground chambers. In addition to the essential requirements of low flow resistance and lengthy operation, a collection efficiency of 99.9% was visualised when the particle concentration was of the order of 0.2 to 0.4 gr./1,000 cu.ft. It appears that the suggestion of C. E. Lapple that glass fibres might be more effective than the sand filters inspired the present investigation. The experimental equipment is described and the method of correlation of experimental data is fully discussed for the determination of flow resistance, collection efficiency and comparative life expectancy of the glass-fibre packings tested. Finally, the method used to design an actual filter is described.

The resistance to flow of atmospheric air was shown to vary as the diameter of the glass fibres, when the



[*L. A. Mitchell Ltd.*

A large M.C.R. retractable tank filter. This filter will accommodate products which have a heavy residue. Plates can be spaced at any distance apart to allow for a cake thickness up to 3 in. or more. Cake can be reduced to a semi-dry condition with blow down and removed by hand scraping or in some cases by merely tapping the edge of the plate. This solves the sewer disposal problem with a heavy cake, which frequently amounts to a ton in a 1,000-sq.ft. filter.

air flow (which was laminar) was in the range of 5 to 100 ft./min. For example, the relationship obtained for Owens Corning AA *Fiberglas*, which has a mean fibre diameter of 1.3 microns, when packed to a density of 0.6 lb./cu.ft. is given by

$$\triangle P = 0.082\, L \rho_p^{1.5} V$$

in which $\triangle P$ = pressure drop (inches of water), L = depth of bed (in.), ρ_p = packing density (lb./cu.ft.) and V = superficial velocity (ft./min.). In order to determine the life expectancy, methylene-blue smoke was introduced into an air stream at a suitable concentration. Large-scale units built according to the experimental design data have been operating at an efficiency greater than 99.9% and probably near 99.99%.

There appears to be little doubt that fixed-bed glass-fibre filters will prove to be advantageous for the removal of submicron-size particles which may be present in low concentrations in air streams.

Details of the Hersey reverse-jet filter are presented by K. J. Caplan.[37] A thick, dense, wool-felt cloth is used for the operation and this results in very high collection efficiencies. In order to avoid clogging, which appears to be inevitable in the usual plant unit, a jet of high-pressure gas (or air) is made to impinge on the reverse side of the cloth whilst it is tautened over the jet system. In this way the fibres are opened and the cloth kept substantially clean.

L. Terry[38] has given an account of experiences with filter fabrics, especially those encountered which have lack of resistance due to repeated flexing and creasing. Poor cake release due to fuzz on the cloth surface is considered and the suggestion is made that flame-singed cloth might be provided as a standard material.

Wire-mesh demisters are described and their performance discussed by O. H. York.[39] This contrivance is a knitted wire mat, fabricated with very fine wire (0.011 in. diam.) to a definite density (12 lb./cu.ft.) and thus giving a very large surface area (110 sq.ft./cu.ft.). Entrainment separation efficiencies greater than 99.9% by weight are obtained over a wide range of vapour velocities. They are made in several metals, as appropriate; for example, *Monel* for a distilling tower and nickel for a caustic soda evaporator.

Several interesting papers have appeared relating to pumps and pump design. The paper by Mitchell[40] describes several types of modern pumps, including the Oliver diaphragm slurry pump, whilst Litzenberg and White[41] discuss the design and development of the newly developed *Chempump*. In an article dealing with chemical feeding and proportioning equipment, Henke[42] discusses materials of construction. In the case of pumps for filter aid—diatomaceous earth—there is, in general, excellent corrosion resistance by plastics, non-metals (*e.g.* carbon) and alloys (*e.g.* Al bronze).

An ancillary often used with filtration apparatus is the continuous thickener. A very informative paper by Comings *et al.*[43] discusses the phenomena associated with this process and suggests that four quite distinct zones of concentration may be distinguished. The authors have extended the concepts of Stokes' law and evolved a general expression for the settling of non-flocculent slurries under hindered settling conditions.

Berline[27] draws attention to the use of hydrocyclones as ancillary units to filtration plant. In contrast, the performance characteristics of centrifugal scrubbers, as an experimental study, are discussed by Johnson *et al.*[44] The object in this case was to determine the efficiency of wet scrubbers for the removal of radioactive aerosols.

Filters in chemical processes

An article by Bradley and Kronowitt[45] deals with the manufacture of the remarkably fast anthraquinone vat dyes, during which several filtration operations are involved. Filtration is accomplished in filter presses (cast iron and also wood construction), suction filters (steel boxes lined with acid-proof brick, and a porous stone bottom, for acid filtrates) or pressure filters (cylindrical tanks containing 70 sq. ft. filter area). The cloths used are of cotton, wool, *Dynel* or *Vinyon N*. The pressure filters are equipped with flat stirrers parallel to the filter bed. One is lined with acid-proof brick and uses a porous stone filter, whilst others use wool and cotton filter cloths, respectively. Although the porous stone gives the best results, there is always the tendency to clogging of the pores when the filtrate crystallises out inside the stoneware. Pressure is secured by means of inert gas, or air, at 45 p.s.i. When it is appreciated that the great majority of the dyestuffs are sold as pastes, the significance of the filtration processes becomes at once apparent.

A description of a process operated in Florida, in which alfalfa leaf meal is extracted with a blend of hexane and acetone for the recovery of chlorophyll, is given by Judah *et al.*[46] The chlorophyll is recovered along with carotene and the solution submitted to a saponification process. A pressure leaf filter is used to remove the wax-

like impurities after saponification. A filter termed a 'Buchner funnel' is used for the removal of carotene crystals.

Potential sources of valuable metals are the naturally occurring silicates, which, however, yield difficultly separable silicic acid gels on treatment with acids, in the normal manner of a digestion process. An interesting contribution by Gee and Huff,[47] of the University of Maryland, deals with this problem. Experiments were conducted on the decomposition of olivine (an orthosilicate of the general formula $(Mg, Fe)_2SiO_4$) by means of 20% by weight HCl. Olivine occurs abundantly and is easily obtained. If decomposition can be secured satisfactorily it should be a large source of Mg, as well as of Cr and Ni which are commonly associated with it. The object of the research was to so modify the silicic acid gels, which would be obtained in the normal manner on digestion at the boiling point (109°C.), that the rate of filtration would be considerably increased. This has been achieved by a stepwise process of digestion, in which a definite increment of the ore was digested with the stoichiometric amount of acid, then the remainder of the ore was added. The nature of the gelatinous material was so changed that a tenfold increase in the filtration rate was secured. The materials of construction for the pilot plant are of interest. The reactors were constructed of *Haveg* and were fitted with *Karbate* reflux condensers and *Haveg* turbine-type agitators. *Pyrex* acid pumps, *Hastelloy* slurry pumps and *Haveg* piping constituted the auxiliaries. The filtration equipment was constructed of *Monel* metal, and consisted of a 3-ft. diam. × 1-ft. face vacuum filter as well as a Sweetland-type leaf pressure filter. A filter aid was used to coat the leaves of the leaf filter.

The manufacturing process for the nitrofurans is described by Sanders *et al.*[48] Of especial value is nitrofurazone (5-nitro-2-furaldehyde semicarbazone), and the first step in the process is the preparation of 5-nitro-2-furaldehyde diacetate, using furfural, acetic anhydride and nitric acid. After appropriate processing and cooling, the sugar-like crystals of the diacetate are deposited. They are then separated from the acetic acid mixture by filtration through a nutsche filter, 4-ft. diam., covered with a 35 × 250 stainless-steel wire cloth. The process is completed by reaction of the diacetate with semicarbazide in the presence of dilute sulphuric acid, when, after 2 hr. at 90°C., the nitrofurazone is formed and precipitated. The semicarbazide required is manufactured by interaction of urea with hydrazine (85% hydrazine hydrate) and the product is precipitated from the pre-filtered solution after cooling. Final recovery, from the cooled liquor, is on 4-ft.-diam. nutsche filters on which are used the same type of stainless-steel wire cloth.

In the manufacture of common salt, several filtration operations are often required. In a comprehensive account of an American plant, Hester and Diamond[49] discuss the filtration units employed. The de-watering of the washed crystals is performed on a rotary, top-feed, vacuum filter and the filter cake is washed with brine. In place of the cast nickel alloy more commonly used to resist the corrosion expected in this operation, this unit is of welded construction built up from 316 ELC stainless-steel plate.

J. S. Anderson described experiences in the filtration of a manganese dioxide concentrate from a froth flotation unit.[50] The pulp contains some 25% solids in a dispersion containing some 450 lb. soap and diesel fuel oil per ton of finished product. This is a particularly obnoxious pulp to handle and the author describes the methods and plant adopted in order to overcome the difficulties encountered.

Milorganite is the dried sludge from the treatment of sewage by the activated sludge process. It is a valuable fertiliser and contains appreciable quantities of vitamin B_{12}. In a paper by Stevens, Wolnack and Zinn[51] a description is given of a pilot-plant installation designed for the extraction of the vitamin in a liquid-solid extraction process which employs an Oliver horizontal filter as the extraction unit. This unit has been described.[52]

Miscellaneous processes

Phosphate tailing is a very finely divided suspension of clay, quartz and phosphate mineral resulting from the beneficiation of phosphate ore by washing. The usual methods adopted for the separation of these solids have been shown to be valueless. A paper by Thompson and Vilbrandt[53] presents experimental procedures and the results obtained when ultrasonic energy is used, and its effect on the settling characteristics of this suspension.

A paper on pilot-plant studies by Bartels *et al.*[54] contains an interesting section on filtration, in which small, bench-scale apparatus is described by means of which rapid observations may be made. The use of unplasticised polyvinyl chloride in the construction of chemical engineering units is described by G. S. Laaff.[55] A rotary drum filter constructed of this material and operating at a plant making H_2O_2 had a useful life of four years. Applications to many industrial processes, resistance to various materials at 72 and 140°F., effect of certain agents on physical properties, factors influencing chemical action and factors to be noted in fabrication are given.

A valuable paper by Lapple[56] deals, in a qualitative manner, with the techniques and plant used in the prevention of atmospheric contamination, together with useful discussions on associated topics as, for example, particle size. Twelve useful references are given. Following this contribution, Lapple and Kamack[57] give an account of an experimental investigation into the removal of particulate matter from gas streams. The dusts used were two grades of talc, titanium dioxide pigment and ground ilmenite ore. The pigment particle size was between 0.1 and 1 micron and electron microscope measurements of the thickness of the tiny plates of talc showed them to be from 0.3 to 0.5 micron thick. The devices used as contactors are the cyclone, sieve-plate, venturi, S-bend pipeline and orifice plate. It was stated that the injection of an amount of steam corresponding to two to three times that required for saturation results resulted in a marked increase in dust collection efficiency. All the scrubbers gave approximately the same degree of collection of dispersed dust, when compared at the same gas power consumption.

Associated with this topic is the particle-size distribution of aerosols and, in a paper by Gillespie and Johnstone[58] dealing with hygroscopic aerosols, the effects of relative humidity of the air stream used in the experiments and nucleation are emphasised and fully discussed. A full description is given of the experimental procedures adopted for the artificial creation of aerosols of industrial importance, and the method of calculation of the size distribution (log-probability function). The laboratory results were found to compare favourably with the size distribution results obtained in the stack of a commercial contact sulphuric acid plant.

The associated topic of viscous flow in systems related to filtration is discussed in three papers which present a mathematical treatment of the subject. Happel and Byrne[59] contribute a discourse on the motion of a single sphere along the axis of a cylinder through which a viscous fluid is

moving. This is followed by an experimental study, by Happel and Epstein,[60] on the relation between pressure drop and fractional void volume, in continuation of the mathematical treatment of the previous paper. Related to these contributions is a translation from the Japanese of a paper by Shigeo Uchida.[61] This again is a mathematical treatment of the subject of slow viscous flow through a mass of particles.

Permeability, as it relates to kaolinite, has been studied by Michaels and Lin.[62] It is shown that there is a marked decrease in the permeability as the polarity of the fluid used increases. The Kozeny-Carman equation did not hold good for this case. 'The most important factor controlling the permeability of kaolinite appears to be the degree of dispersion or disaggregation taking place in the original suspending fluid.'

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METALLURGY

By H. A. Holden, M.SC., A.R.C.S., D.I.C., A.I.M.

Aluminium and its alloys; titanium developments; new ferrous and non-ferrous alloys; processes; protective treatments; testing of metals

Aluminium

IN view of the recent celebration of the centenary of aluminium as a commercial metal, it is appropriate that this metal should be considered first. Super-purity aluminium is not new, but it is only now becoming readily available in commercial quantities.[1] Its applications for building, cable sheathing, electrolytic condensers, reflectors and decorative purposes have very recently been reviewed by Champion and Spillett.[2] It would seem that one of its potentially most important uses is as decorative trim for motor-cars, where in the brightened and anodised condition it is claimed to give a very good colour match with chromium plate.[3, 4] Considerable interest is being shown in suitable electrolytic and chemical brightening or polishing processes,[5, 6, 7] and super-purity aluminium chemically polished and anodised or aluminium alloys given only a relatively small amount of mechanical polishing followed by electrolytic brightening and anodising may feature prominently on British cars before long. The use of aluminium for bumpers has been forecast for American automobiles.[8]

Anodising itself has also been the subject of further investigations, particularly the so-called hard anodising processes.[9, 10] These produce hard oxide films of 2-mil thickness or more and have been suggested as alternatives to hard chrome. In general, their corrosion properties as determined by salt-spray testing are claimed to be superior to conventional anodic coatings, but Johnson[11] has reported that at 80 to 90°F. the coatings deteriorate in a humid atmosphere and their abrasion resistance is reduced. Another anodic treatment, *Ematal*,[12] in which an oxalic bath containing titania is used at high c.d., produces a dense, opaque, high-gloss finish more like vitreous enamel than an oxide film. The vitreous enamelling of aluminium is still very much in the news in the U.S.A.,[13] and Biechler and Meynis de Paulin[14] have reviewed the subject with particular reference to the Du Pont enamels. So far, the process has found no commercial applications in Britain.

A recent innovation in the field of sintered aluminium powder products (S.A.P.) is its introduction in sheet form under the trade name of *Hiduminium* 100. Doyle,[15] in reviewing its manufacture and properties, stresses that in comparison with commercial pure titanium (A. 55) it has higher specific proof stress values at all temperatures up to 500°C., higher specific ultimate strength values up to about 320°C., and up to about 200°C. a superior Young's modulus/density ratio. It has good corrosion resistance, is not susceptible to intercrystalline corrosion and stress corrosion, has high fatigue resistance, high-temperature strength, and the unique charac-

teristic of recovering its full properties after long soaking at temperatures up to 500°C. *Hiduminium* 100 sheet, however, cannot be formed by usual methods and, for deep drawing and contour forming, the *Dyzacking* technique has to be employed. A more general picture of sintered aluminium powder and the precipitation-hardening characteristics of S.A.P. alloys containing 0 to 5% copper and magnesium and 0 to 15% Al_2O_3 was given by Irmann[16] at the symposium on powder metallurgy arranged by the Iron and Steel Institute. Information on the preparation of aluminium alloys containing up to 20% Ni, Co, Fe, Mn, Cr and Ti by cold pressing, sintering and final hot coining and hot pressing followed by extrusion was also given by Macdonald and Ransley[17] at the same gathering.

New alloys include aluminium-bearing metals with up to 30% Sn and with or without ~3% Cu which give greater strength and rigidity where solid bearings are used,[18] and two new extrusion alloys.[19] One (66S) is a low-cost, general-purpose material bridging the gap between 61S and 24S but with good fabricating characteristics, and the other (HZM 100) is a high-strength alloy designed for optimum mechanical properties in extrusions and forgings. It has a guaranteed U.T.S. of 89,000 p.s.i. and a Y.P. of 82,000 p.s.i. Pilot-plant trials have shown that Al-Cu-Cd alloys have excellent hot workability[20] when rolled to sheet, and Vosskühler[21] has shown that the high-temperature creep properties of *Hydronalium* Hy 51 (Mg 5%, Si 1%, Mn 0.2%) can be improved by raising the Mg and Si contents and additions of Cu ~0.5% and Ti 0.1%.

A comprehensive survey of published information on the fusion welding of aluminium has been issued, together with details of the extensive work which the British Welding Research Association has carried out on that subject.[22] Details have also been released of the new *Thesscal* hard soldering process for aluminium which utilises zinc-base solders with an inorganic flux.[23, 24]

High joint corrosion resistance is one of the principal claims for this technique which, in addition to its use for repairing or joining aluminium castings, can also be employed for joining aluminium to Cu, Ni and their alloys, mild steel and stainless steel.

Titanium

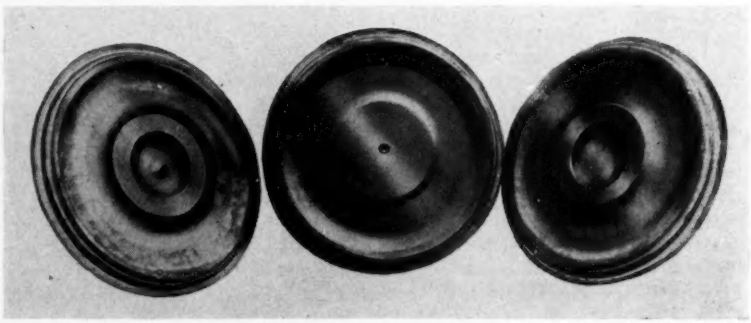
During the past year titanium has once again received more attention than any other metallurgical subject, and in a review of this type only a small number of the more important developments can be mentioned. It is now becoming clear that in the past exaggerated claims have been made for the metal, and a really first-class critical review of its use in civil and military aircraft has recently been published by Promisel.[25] He states that weight saving is the only justification for its use, as its virtues as a material of construction, its corrosion resistance (with exceptions), strength at elevated temperature, absence of magnetic properties, etc., could be obtained more economically by other more conventional means. As present-day deficiencies he lists lack of uniformity and reliability of quality; high cost; low elastic modulus; instability at elevated temperatures (500 to 1,000 °F.); inability to resist sustained static and vibrating loads; lack of a formable, preferably weldable, sheet alloy, high-strength forgings and extrusions of good ductility; the large production of scrap and the limited re-use of such materials.

More information has been issued on the annealing,[26] fusion welding[27] and frictional properties of titanium,[28, 29] and some particularly valuable reports from Watertown Arsenal which have only fairly recently become available in Britain deal with nitriding and carbonitriding,[30] siliconising,[31] fatigue,[32] welding,[33, 34] chemical surface treatments[35] and vapour-deposited coatings.[36] The two types of bath which give adherent, continuous coatings of value in reducing galling and for wire and tube drawing are (*a*) 5% caustic soda (anodic treatment) and (*b*) fluoride-phosphate or fluoride-borate solutions. The vapour-deposited molybdenum coatings produced by the decomposition of $Mo(CO)_6$ can be applied in 1 to 2 hr. without affecting the mechanical properties of the base metal and show excellent wear resistance. Tests[37] in which commercially pure titanium was exposed to marine, industrial and rural atmospheres for about five years and to sea water for 4½ years showed that it appeared to be completely unaffected. Renshaw and Bish[38] have discussed the advantages of titanium in the chemical industry and suggest that it may be useful for handling nitric, phosphoric, hydrochloric, chromic and acetic acids. As for production, details have been given of a new process involving the vapour-phase reduction of $TiCl_4$ by Mg[39] and of I.C.I.'s plans for titanium production in this country.[40] American plans are for 25,000 to 35,000 tons of titanium sponge during 1957.

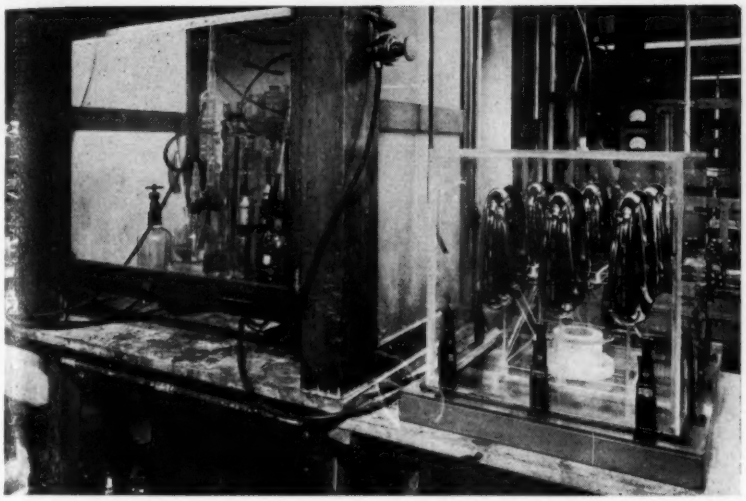
New alloys

New copper alloys particularly suitable for the production of cast parts are Cu-As, Cu-Sb, Cu-Pb and Cu-Pb-Si with and without small additions of Al, Cr, Fe, Mn, Ni, Sn and Zn.[41] Of these, the Cu-Pb-Si bronzes (' Ingros bronzes ') are claimed to produce castings with bright, oxide-free surfaces which can be easily polished and electroplated. A range of new copper-base alloys containing tin has also been described by Ellwood[42] and includes (*a*) tin bronzes containing beryllium, (*b*) tin bronzes containing manganese —developed to replace copper-nickel alloys for deep drawing and (*c*) cupronickels containing 15% Ni and 3 to 5% Sn for punching and stamping. New low-melting-point alloys composed of Sn, Pb, Bi and Cd have been reported[43] and one, *Cerrolow*, has a melting point of 47.2°C. coupled with very low shrinkage. Suggested uses are for patterns, fine tube bending, safety plugs, etc., and applications where hard lead, type metal or Woods metal are normally employed.

In the sphere of ferrous metallurgy, NA22H and *Carillay* T-1 are a new casting alloy and an extra tough quenched and tempered steel introduced by the American Blaw-Knox Co. and U.S. Steel Co., respectively.



Titanium compressor disc stampings. [*Wm. Jessop & Sons Ltd.*



British Non-Ferrous Metals Research Association

Accelerated corrosion test using an atmosphere of moist sulphur dioxide to assess the behaviour of nickel-plated bumper bar over-riders.

The former (C 0.5%, Ni 48%, Cr 28%, W 5%, Fe balance) is claimed to be superior in structural stability and oxidation resistance to other standard nickel-chrome compositions and to be suitable for service up to 2,200°F. for radiant tubes, heat-treatment furnaces, retorts, etc.[44] The latter (C 0.15% with Mn, Ni, Cr, Mo and B all <1%) is stated to show outstanding performance when used for pressure tanks even without stress relieving, and Gray[45] has, described trials in which four large pressure tanks were tested to destruction in bursting and impact tests at –45°F. In the United Kingdom, *Fortiweld* steel is attracting some attention as a material going some way towards satisfying the modern need for a high-strength steel with good weldability, good formability and strength at temperature. It is a low-carbon alloy steel similar in chemical composition to the well-known 0.5% Mo superheater tube steel, but it is treated with boron. Its properties and applications have been discussed by Tremlett.[46]

New techniques

The *Mercast* process is a new investment casting technique claimed to be suitable for the production of larger (up to 300 lb.) and more complex shapes than other forms of investment casting. These advantages are due in part to the self-welding properties of frozen mercury and also to the high surface tension and density of liquid mercury which enable the finest details of the die to be filled. The pattern is prepared by pouring mercury at room temperature into a steel die and then freezing the mercury (–73°C.). A clean, smooth pattern is obtained and the relatively low expansion of mercury on melting enables a thin, ceramic shell mould ($\frac{1}{16}$ to $\frac{1}{8}$ in. thick) to be used. This is built up by dipping the pattern into slurries of increasing viscosity at –62°C. The mercury is then washed and melted out and the mould is ready for firing.[47–51] Further work on plaster as a mould material for casting the light metals has been described by Gardener,[52] and castings of sections $\frac{1}{16}$ to $\frac{1}{8}$ in. thick with a surface finish of 125 R.M.S. can now be produced. Although all aluminium and magnesium sand casting alloys are suitable for this process, silicon-containing-aluminium alloys are best for thin sections. Special inhibitors have to be added to the plastic mould for magnesium casting.

Comparison of impact, high-temperature properties, fatigue and general service data of steels and nickel-chromium alloys produced by vacuum melting and melting in air shows the superiority of the vacuum-melted material.[53] This is due to increased freedom from inclusions, elimination of gaseous or gas-metal compound precipitation and better composition control. Metals produced using this process are likely to be of pronounced benefit to the chemical industry principally because of their essentially inclusion-free surface. Calcium carbide injected into molten iron by means of dry nitrogen removes sulphur and provides a most satisfactory base iron for subsequent spheroidisation.[54] The sulphur content may be readily reduced from 0.2 to <0.02%, thus enabling high-strength irons to be obtained with more economical alloy additions. Platon[55] has given some details of his P.A.P. process for deoxidising steel by the addition of liquid aluminium and the L.P. mould coating which it is claimed eliminates dirty ingot surfaces by fluxing impurities and the limited evolution of gas.

A new process called *Chem-milling* is claimed to offer advantages for precision contouring of forgings or intricately shaped and curved aluminium sheets. Although principally applicable to aluminium, it is also stated to be suitable for carbon and stainless steels, titanium and some other metals. In essentials it consists of controlled etching, using acid, alkaline or electrochemical etching techniques, the areas not requiring treatment being suitably stopped-off.[56–59] According to Sanz,[60] the cost of the etching equipment is less than 7% of that of skin-milling machines and he has published some details of his experience with the 'chemical milling' process on 24S and 24S-T3 *Alclad* sheet. Data on the fatigue and tensile strengths of both these alloys are given and the machine-milled and etched materials are compared. Other novel machining techniques receiving attention are those involving high-frequency vibration,[61] ultrasonics[62] and electrolytic action. By using cutting tools vibrated at high frequency, material is removed by the rubbing or hammer action of abrasive powder particles in a liquid suspension between the tool and the work. Although limited to brittle materials, the technique is well suited for the making of dies, as complex shapes with high fidelity of detail can be cut. The advantages of a process of metal removal in which conventional grinding is accompanied by simultaneous electrochemical decomposition of the work have been reviewed by Comstock.[63] It is stressed that the rate of metal removal is low, which limits its application to operations in which low removal rates are acceptable, providing that compensating advantages are obtained.

Protection

A 'new' steam oxidation process for iron and steel, claimed to provide an excellent paint base at 20 to 25% less cost than chemical surface preparation, has been announced by Singer Manufacturing Co., Bridgport, Conn.[64] Treatment is carried out in a modified Leeds & Northrup pit-type, sealed retort, forced-circulation furnace. This is heated to 650°F., the

parts introduced and, when temperature has been regained, steam introduced and the temperature reset to 750°F. Steam is then passed through the furnace for 15 min., the outlet valve closed and processing continued for a further 35 min. The work is then removed and allowed to cool. Coatings of Sn-Cd alloy or cadmium deposited over an equal thickness of tin were found by Britton and Stacpoole[65] to have outstanding durability in laboratory salt-spray tests and in all environments as well able as cadmium to prevent rusting at pores when freshly exposed to corrosion. Compared with cadmium coatings, however, the alloy coatings were no better in continuous or intermittent sea immersion and were inferior in exposure in inland urban atmospheres. Yet a further development in protective coatings concerns a new process for improving the light-fastness of organic dyes on anodised aluminium.[66] Organic dyestuffs used for colouring anodised aluminium are, of course, not particularly fast to either light or weathering, but the results of 'fadeometer' tests indicate that with some dyes a considerable improvement can be effected by a final sealing treatment with a hot solution of lead acetate, copper sulphate or zinc chloride for about 30 min. followed by hot-water rinsing. Cathodic protection is now widely employed as a method of preventing corrosion, but it has recently been shown that anodic protection can be equally efficacious in certain special circumstances. Edeleanu[67] has described a pilot plant, for testing the anodic protection of stainless steel in a boiler used for sulphuric acid solution, with completely satisfactory results.

Tests and testing equipment

Amongst new tests of interest to metallurgists, chemical engineers and chemists is a simple method for determining the decarburising properties of a salt bath. If the bath needs attention, a razor blade after immersion for a standard time will bend without snapping.[68] Farrer[69] has discovered that aqueous suspensions of elemental sulphur rapidly attack iron and steel and, as this reaction is specific to ferrous metals, has suggested that it may be used as a means of detecting pores in coatings applied to these metals. Some further work[70] on this reaction has shown that corrosion decreases considerably when the pH is raised to 9 or lowered to 4. Also, negligible attack was noted when dispersions of common sulphur cements were used in place of elementary sulphur. The most commonly employed and at the same time the most widely criticised accelerated corrosion test is, of course, the 'salt-spray' or 'salt-mist' test. Originally designed to use 20% sodium chloride solution, the strength of the salt solution was later reduced to 5% and the most recent modification is the introduction of 5% sodium chloride and 1% acetic acid (pH 3.2) at 95°F.[71] Although more severe than the ordinary salt-spray test, the acetic acid test is stated to give results more comparable with those obtained in service for copper/nickel/chromium coatings on steel. The results of a co-operative investigation into a rapid electrolytic oxalic etching test to supplement the boiling nitric acid test used to measure the susceptibility to intergranular corrosion of cast stainless steels have also been published.[72] Using cast CF-8 and CF-8M stainless steels, the method was shown to be capable of eliminating the necessity for the nitric acid test on all samples. Appreciable quantities of ferrite in the structure did not affect the use of the test.

New instruments include the G.K.N. micro-hardness tester;[73] portable Vickers hardness testers[74] for use on objects which are too large or too heavy to be placed on the stage of the normal Vickers pyramid hardness testing machine; a thermoelectric metal comparator developed by General Motors Corporation which can be used for identifying metal stocks;[75] a precision sheet-thickness meter[76] which employs the principle of saturation magnetisation; and an instrument for the measurement of surface roughness.[77] The last is claimed to be an advance on the profilometer as, in addition to recording the average surface roughness R_a and the R.M.S. roughness R_s, the instrument can be used to determine the average roughness height R_p, total height R_t, and average roughness depth $R_m = R_t - R_p$.

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Dust Collection Efficiency and Costs

PERFORMANCE OF VARIOUS TYPES OF EQUIPMENT COMPARED

OVER the past few years a number of papers have been published describing in general terms the various types of dust collectors available, and giving, in certain cases, suggested application. Few of these papers make any serious attempt to compare the different collectors in respect of plant performance. There are two possible reasons for this omission: (1) the collection of accurate performance data is time-consuming and expensive; and (2) isolated data for plant on different duties are difficult to compare, and no standard method of presenting the results has yet been reported.

This was pointed out in a recent paper which aimed at meeting the latter difficulty in two ways:

(1) By preparing typical 'grade-efficiency' curves in which the achieved performances of the dedusters are expressed in terms of the collection efficiency for the various size grades of particles;

(2) By deducing, from these test curves, the collection efficiency of each deduster on a standard test powder, so that direct comparison can be made.

The paper was presented to the Institute of Fuel, in London, by C. J. Stairmand, B.SC., M.I.CHEM.E., A.INST.P., of Imperial Chemical Industries Ltd., Billingham Division. He reviewed the main methods of large-scale dust collection—namely cyclones, electrostatic precipitators, fibre and fabric filters, and wet washers, including impingement scrubbers, disintegrators, spray towers and venturi scrubbers. In each case a brief discussion of the probable mechanism of operation was given, with a practical 'grade-efficiency' curve, obtained for accurate tests on installed plant. Finally, a method of economic assessment was described, showing how the collectors can be compared in terms of total operating costs, related to their collection efficiencies on a standard test dust.

The grade-efficiency curves given can be used to predict the overall dedusting efficiency of any particular dust collector on any given dust. However, in certain cases it may be useful to have a single figure of merit to give a rough initial assessment of the performance of the dust collectors reviewed.

Dust collectors' efficiency compared

A convenient way of obtaining such a comparison is to determine the overall collection efficiency on a standard test dust. One such standard test dust used in certain of the I.C.I. laboratories is grade W.C.3 silica powder,* which has a grading about the same as typical fly ash from a modern pulverised-fuel boiler. The grading of this standard dust is given in Table 1.

Column 3 of Table 2 gives the (calculated) overall collection efficiency for the various dust collectors reviewed.

A further single figure of merit is given by the percentage efficiency at 5μ. Values taken from the appropriate grade-efficiency curves are given in column 4 of Table 2.

* Obtainable from Colin Stewart Ltd., of Winsford, Cheshire, at approximately £12/ton.

These figures serve to place the dust collectors in order of merit, at least so far as collection efficiency is concerned. A more useful assessment includes some consideration of the cost of installing and running the plant; an attempt at such an assessment is made below.

Assessing the cost

The preparation of accurate cost figures for dedusting installations is difficult, since the figures vary considerably with the site conditions and with the size of the plant. Thus an order of merit for a given size of installation may be entirely changed when a plant of, say, three or four times the size is considered. It is thought, however, that some sort of comparison will be of interest even if only for preliminary guidance. Table 3 has therefore been prepared for various plants to deal with 60,000 cu.ft./min. of gas at 68°F., loaded with approximately 5 gr./cu.ft. of dust, of the standard grading shown in Table 1. The notes appearing below the table are important and should be read in conjunction with the figures in the table.

It will be seen from Table 3 that the cost of dust collection ranges from about 0.01 to 0.22 pence per 1,000 cu. ft. of gas cleaned, the cost rising rapidly for the higher efficiencies. While this is to be expected, it is of some interest to inquire whether any of the dedusters are either much cheaper or much dearer than their performance warrants. When the total cost of dedusting, in pence per 1,000 cu. ft. of gas, is plotted against the performance factor:

Table 1. Grading of W.C.3 Test Dust

Size of grade (microns)	*Percentage by weight in grade*	*Percentage by weight smaller than top size of grade*
104 to 150	3	100
75 to 104	7	97
60 to 75	10	90
40 to 60	15	80
30 to 40	10	65
20 to 30	10	55
15 to 20	7	45
10 to 15	8	38
7½ to 10	4	30
5 to 7½	6	26
2½ to 5	8	20
<2½	12	12

Table 2. Overall Collection Efficiency on W.C.3 Test Dust

1 *Apparatus*	2 *Section*	3 *Overall efficiency, %*	4 *Efficiency at 5μ, %*
Medium-efficiency cyclone	3.1	65.3	27
High-efficiency cyclone	3.1	84.2	73
Low pressure-drop cellular cyclone	3.1	74.2	42
Tubular cyclone	3.1	93.8	89
Irrigated cyclone	3.1	91.0	87
Electrostatic precipitator	3.2	94.1	92
Irrigated electrostatic precipitator	3.2	99.0	98
Fabric filter	3.3	99.9	>99.9
Spray tower	3.4	96.3	94
Wet impingement scrubber	3.4	97.9	97
Self-induced spray deduster	3.4	93.5	93
Disintegrator	3.4	98.5	98
Venturi scrubber	3.4	99.7	99.6

Table 3. Approximate Costs of Various Dedusting Systems Treating 60,000 cu. ft./min. of Dusty Gases at 68°F.

Equipment	Efficiency on standard dust, % (1)	Capital cost, £		Pressure drop in. w.g.	Power cost, £ p.a. (3)	Water usage, gal./1,000 cu. ft.	Water cost, £ p.a. (4)	Maintenance, etc., £ p.a. (5)	Total running cost, £ p.a. (6)	Capital charges, £ p.a. (7)	Total cost, including capital charges		Overall equivalent pressure drop, in. w.g. (8)
		Total (2)	per cu. ft./min. capacity								£ p.a.	d./1,000 cu. ft.	
Medium-efficiency cyclones	65.3	3,300	0.05	3.7	1,690	—	—	60	1,750	330	2,080	0.017	4.6
High-efficiency cyclones	84.2	6,300	0.10	4.9	2,260	—	—	60	2,320	630	2,950	0.025	6.4
Tubular cyclones	93.8	6,900	0.11	4.3	1,980	—	—	60	2,040	690	2,730	0.023	5.9
Irrigated cyclones	91.0	7,800	0.13	3.9	2,030	4.0	660	150	2,840	780	3,620	0.029	7.0
Low-pressure-drop cellular cyclones	74.2	5,600	0.09	1.4	655	—	—	60	715	560	1,275	0.011	2.7
Electrostatic precipitators	94.1	30,700	0.51	0.6	620	—	—	250	870	3,070	3,940	0.033	7.6
Irrigated electrostatic precipitators	99.0	52,800	0.88	0.6	1,120	2.5	440	400	1,960	5,280	7,240	0.060	14.0
Frame-type fabric filter	>99.9	17,600	0.29	4.0	1,880	—	—	3,180*	5,060	1,760	6,820	0.057	13.2
Reverse-jet fabric filter	>99.9	17,000	0.28	5.0	3,990	—	—	2,700†	6,690	1,700	8,390	0.070	16.2
Spray tower	96.3	18,300	0.30	1.4	2,375	18.0	3,300	300	5,975	1,830	7,805	0.065	15.0
Wet impingement scrubber	97.9	10,300	0.17	6.1	2,900	3.0	550	300	3,750	1,030	4,780	0.040	9.2
Self-induced spray deduster	93.5	8,700	0.15	6.1	2,820	0.6	110	200	3,130	870	4,000	0.033	7.7
Venturi scrubber	99.7	15,000	0.25	22.0	10,570	7.0	1,210	300	12,080	1,500	13,580	0.11	26.2
Disintegrator	98.5	23,800	0.40	—	22,700	5.0	850	200	23,750	2,380	26,130	0.22	50.5

(1) See Table 1.
(2) Includes fans, pumps, motors and erection. Corrected to 1955 values.
(3) Cost of electrical energy assumed 1.2d./kwh. Fan and motor efficiency taken as 60%.
(4) Cost of water assumed 0.15d./100 gal.
(5) Estimated figure.
(6) Assuming 8,000 hours' operation p.a.
(7) Taken as 10% of capital cost.
(8) Total annual cost expressed as power usage.

* Includes complete change of bags once a year.
† Includes complete change of bags twice a year

$$\frac{\text{Percentage collection efficiency on standard silica dust}}{\text{100 – percentage collection efficiency on standard silica dust}}$$

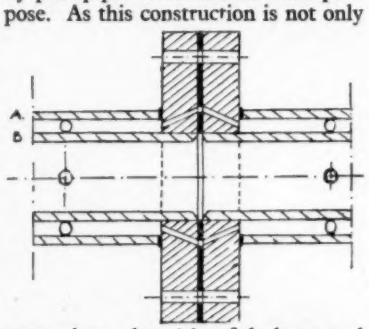
that is, $\frac{\eta}{100 - \eta}$,

it will be seen that most of the points lie fairly closely on a straight line. The disintegrator is far above the line, largely on account of its high power usage, while the tubular cyclones and the fabric filters are below the line. A rather surprising feature is that electrostatic precipitators lie on the average line, and are not, as is sometimes asserted, unduly expensive in total cost, considering their performance.

Summing up, the author points out that dedusters are available which will collect a fine industrial dust, containing 30% by weight of particles smaller than 10μ, with efficiencies ranging from 65 to virtually 100%, at a total operating cost, including capital charges, from about 0.01 to 0.22 pence per 1,000 cu. ft. of gas treated. The cost naturally increases with the dedusting efficiency, though the relatively small-diameter tubular cyclones, and bag filters, are rather cheaper than their performance would suggest. Electrostatic precipitators, particularly for the higher efficiencies (exceeding 99% on the duty considered), tend to be cheaper than wet washers.

A Joint for Steam-jacketed Pipelines

HEATED pipelines are used in practice for the transporation of viscous fluids. One way of heating such pipelines is to surround them with steam jackets through which steam, hot water or hot gases are passed. The difficulty always remains of the manner in which the jackets are joined together at the flanges. Hitherto by-pass pipes were used for this purpose. As this construction is not only



exposed to the risk of leakage and freezing in winter time, but is often also impracticable owing to lack of space, a search was made for another solution.

The solution consists in making a passage for the steam straight through the flanges, so that no additional space is required for by-pass pipes. The figure shows the two sections of pipeline brought into the flange. They are preferably rolled into the flange with a pipe roller; they are then welded and rolled slightly once again to ensure that they are tight. The flange is provided with holes for the heating fluid, as the figure indicates; these holes are bored in obliquely; their diameter and number can be chosen as desired.

Attention must be paid to the centring of the outside pipe *A*.

For this purpose small spacers are welded on the pipe *B;* there are four of them on the circumference, about 10 cm. from the flanges and in the middle of the pipe between the flanges. It is possible to weld two sections of pipeline, about 6 m. in length, together first before fitting flanges, so that one flange is thus required for every 12 m. In that case, however, it is necessary to use more spacers for centring.

For simultaneous heating, and hence uniform expansion of the two pipes, it is advisable to make the gasket (see figure) very thin, *e.g.* $\frac{1}{2}$ mm., and as large as the diameter of the flange. Holes must then be made in it for the bolts, small holes (*e.g.* 5 to 6 mm.) for the steam passage, and a hole for the fluid passage.—*E.P.A. Digest from Vraag en Aanbod*, 1955, **57** (49), 1.

The Long-Term Aspect of FISSION PRODUCT DISPOSAL

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The radioactive nature of the fission products and the need for containment of all highly active materials impose severe limitations on the choice of chemical operations which can be carried out usefully with these products. Yet, for economical storage of fission products, processes on the multi-ton scale involving hundreds of kilo-curies have to be and are performed regularly. A future large-scale utilisation of individual fission products would require operations on a similar scale. The veil of secrecy which had previously covered this section of chemistry has been lifted since the recent Geneva conference on peaceful uses of atomic energy, and a number of chemical operations are described in this article, some of them novel and capable of being applied to other industrial uses.

AN ASSESSMENT OF THE PROBLEM

IN order to appreciate fully the fission product problem it is necessary to estimate the possible expansion of nuclear energy production.

The British atomic energy programme envisages in the foreseeable future a substitution of nuclear energy for approximately 60 million tons of coal which would otherwise annually be burnt for production of electricity towards the end of this century. In order to do this, it would be necessary to burn up approximately 20 tons p.a. of nuclear fuel.

From the British requirements one can estimate that world consumption of nuclear fuel may eventually reach figures of not less than 200 tons p.a. On the other hand, it is unlikely that a world consumption of 1,000 tons will be exceeded in the foreseeable future, as this would imply an electricity consumption per head of the world population equal to the present United States level, and derived essentially from nuclear energy. From the point of view of the fission product nuisance, a world level of 1,000 tons p.a. in the distant future is thus the most pessimistic outlook we can reasonably accept today. Similar figures have been estimated by Hatch[1] and by Rodger.[2] This level of nuclear energy would be equivalent to twice the present world coal production estimated at 1,500 million tons of coal. If, therefore, we can decide on ways and means to dispose, economically and without danger to ourselves and future generations, of a quantity of fission products of this order, we shall have no need to restrict later on the expansion of nuclear industries on account of the fission product nuisance.

Quantity of radiation from fission products

With the present-day type of reactors, using solid fuel elements, by far the largest proportion of the energy of the fission products is spent while they are in the reactors and in various stages of the recycling process, and it is only those with half-lives longer than months with which the disposal process is seriously concerned.

By the time the fission products are about one year old, 99.9% of the β- and γ-radiation emitted is due to eight elements only — from an original number of 35.

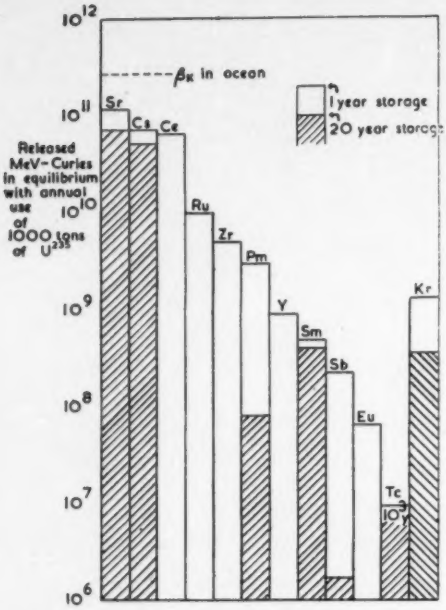
A useful picture, and one which gives a pointer to the actions to be taken, can be obtained if we imagine that the fission products of over one year of age would all be accumulated in one place where they would continue to decay, while every year the waste from 1,000 tons of burned-up material would be added. The activity, under these conditions, would then increase, until for every element there is annually as much decay as there is addition, so that for a steady level of production a steady level of fission product activity would eventually be reached. The equilibrium level of energy dissipation measured in MeV-curies (1 MeV-curie = 0.0059 watts) for individual fission products is shown in Fig. 1 (highest line). This level will not be exceeded, unless an annual production of 1,000 tons is exceeded.

The quantities are enormous by all previously known standards, but these figures are put into their proper perspective if we compare them with the amount of radiation produced by the small percentage of potassium (K^{40}) in the oceans of the world. This almost unnoticeable activity adds up to 2.8×10^{11} MeV-curies, which is just about the amount of activity to which this hypothetical nuclear energy programme could ever lead.

It is interesting to see how this diagram would change if the fission products would be stored not for one year, but for 20 years, before being discharged into the common pool. Under these conditions the nuclides of one year or less half-life have decayed to an insignificant level, and an equilibrium activity distribution would result which is indicated by the shaded portions of Fig. 1. (For very high burn-up rates in enriched reactors, Sm^{151} disappears, but another rare earth, Eu^{154}, with a 16-year half-life, is produced with a similar energy dissipation.)

The scene is now completely dominated by the activity from Sr^{90} and Cs^{137}. If these two species could be quantitatively removed and stored separately, the activity level of the remaining bulk solutions would fall by a factor of 1,000. Indeed, as the toxicity of Sr^{90} is about 25 times greater than that of other β-emitting fission products, the reduction in toxicity caused by a quantitative removal of Sr and Cs would be by a factor of about 25,000.

Fig. 2 shows the decay of biologically weighted activity for a solution batch, first without and then after



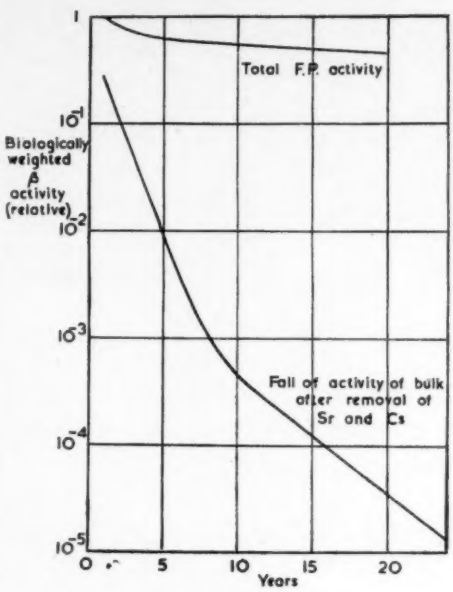


Fig. 1. (*Left*) **Equilibrium activities of individual fission products built up by the annual use of 1,000 tons of fissile material: (*a*) after one year's storage before disposal and (*b*) after 20 years' storage before disposal. For comparison: total β-activity of the potassium of the oceans.**

Fig. 2. (*Right*) **The decay of 'biological' β-activity in a batch of mixed fission products *a* with *b* without prior removal of strontium and caesium.**

removal of Sr and Cs. It shows clearly that in the former case the solution remains at a high level of toxicity for a very long time, while in the latter case there is a rapid and continuing decrease of activity. This feature is of considerable importance in the subsequent discussions on fission product disposal.

It may be worth while to comment here on the level of activity which is introduced into the atmosphere by Kr^{85}, which, being a rare gas, is in the normal course of events released into the atmosphere. A permanent level of the order of 10^9 MeV-curies (see Fig. 1) may appear to be very large, but, by comparing it with the amount of energy released in air at sea level by cosmic radiation, we find that, when completely dissipated in the atmosphere, the equilibrium Kr-activity, even from such a huge nuclear energy programme, would still be less than that constantly dissipated by cosmic radiation. Its influence on living matter would be less still than that of cosmic radiation, as the latter is a body absorption, while the Kr-activity affects mostly the skin only. We therefore can consider the gradual release of Kr^{85} into the air as innocuous for some time to come, though at the highest production levels its storage may become desirable.

Composition and quantities of fission product solutions

The composition of the fission products deriving from 1 ton of U^{235} burnt up depends somewhat on the rate to which the burn-up has proceeded and on the time elapsed since their removal from the reactor. A typical example is represented by Table 1, in which the main elements are ordered according to their position in the periodic table.

These fission products are extracted during a recycling process and, consequently, are mixed with a comparatively large quantity of chemicals which are derived from:

(1) Impurities of the reactor fuel.
(2) Products of the interaction of neutrons with the reactor fuel (Np, Am, Pu, etc.).
(3) Incompletely separated reactor fuel (U or Pu).
(4) Incompletely removed canning or alloying material (Al, Zr, etc.).
(5) Chemicals added during recycling separation.
(6) Corrosion products from plant and storage vessels.

The quantities of these will vary greatly both according to the reactor materials (U natural or enriched, Pu, alloys of these, etc.), according to the recycling process employed (dissolving and extraction, remelting with slag formation, etc.), and they may be insignificant if the fission products are extracted from the gas evolved in homogeneous reactors.

It is essential, from the point of view of fission product disposal and utilisation, that the solutions arising can be concentrated to the smallest possible volume. If solid electrolytes arising from canning or alloying materials, or from salting-out agents employed during the solvent extraction process, are present in excessively large amounts, large volumes will eventually arise and the cost of storage, transport or any type of operation will go up almost proportional to the final volume. These factors should therefore be considered when selecting reactor fuel elements and recycling processes, and they have been taken into account in the British fuel element and processing designs.

An example of the type of fission product solution arising under comparatively favourable conditions in graphite moderated reactors using slightly enriched uranium as fuel elements is shown in Table 2. HNO_3 has been used as salting-out agent in the solvent extraction process which removes the uranium and plutonium. The bulk of original solution is very large, and it is apparent that primary concentration is an essential step before any disposal scheme becomes economical. The only exception to this would be disposal of the original solutions into exhausted oil wells, if such are situated close to the processing plant.[3]

Table 2 refers again to 1 ton of burnt-up U^{235}.

There are also minor constituents such as C, Si, F′, Cl′, Np, Am and Pu which are variable according to irradiation and purity of the original materials used. If future arisings should have a similar composition, then their total quantity in Great Britain, corresponding to 20 tons fissile material burnt, would be approximately $20 \times 25 = 500$ cu. m. of solution p.a.

POSSIBLE SOLUTIONS OF PROBLEM

Various possibilities are now open, of which the most useful ones are discussed:

(*a*) Indefinite storage in tanks (annual storage capacity to be added, 500 cu. m.).

(*b*) Immediate and complete disposal of approximately 1-yr.-old solutions.

(*c*) Processing, involving the separation of the long-lived Sr and Cs. This might be followed
- (i) by immediate disposal of the bulk of solution, or
- (ii) by 13 years' storage, recovery of useful materials from the substantially inactive solutions, and subsequent disposal of the bulk.

(*d*) Separation of Sr, Cs, Ce and Zr for the economical utilisation of the radiations, followed by (*c*) (i) or (*c*) (ii). (A discussion of this point would be premature until there is a large industrial demand for radiation.)

It is necessary to amplify the concept of disposal. The pressure of public opinion is such that we need consider for a disposal only conditions where we have absolute safeguard against:

(1) fission products entering human food or water supplies,

(2) accidential exposure of the public to radiation levels above tolerance,

(3) adversely affecting the access to the mineral wealth above or below ground,

and, in addition, we require that the proposed scheme be economical. Even then a great deal of un-informed public opposition may be encountered.

Disposal at sea

We have already seen that complete and uniform dissipation of all fission products in the sea would eventually reach the activity level of K^{40}, and the high toxicity of Sr^{90} would have the result that the toxicity of the natural K^{40} in the sea would be considerably exceeded. This is therefore undesirable.

After a quantitative removal of Sr and Cs, an immediate and uniform dissipation of all the remaining fission products in the oceans could be considered as safe, but as uniform dissipation cannot be achieved in practice, this scheme would also be undesirable.

However, quantitative removal of Sr and Cs, combined with 13 years' storage, would lead to a product the equilibrium activity of which is less than 1/1,000 of that of the natural K^{40} of the sea. For this type of fission product solution, safe methods can be found for disposal into the sea. One of many possible suggestions would be to drop these solutions in plastic containers into the deepest parts of the ocean where, owing to their high specific weight (>1.5), they would sink and become embedded in the mud of the sea bottom. As the activity is no longer sufficient to cause destruction of the resin, the release into the ocean by occasional leakages would be so slow that no appreciable local build-up of activity would be expected.

Disposal on land

For disposal on land, it will require exceptional circumstances when case (*b*) is being considered. As, due to the long life of Cs and Sr, these solutions will remain highly active for 1,000 years, we shall require either completely deserted and inaccessible areas for the disposal of solutions, or else it will be necessary to turn the radioactive materials into solid products from which the fission products cannot be leached, such as glasses or ignited clays.[4, 5]

For the disposal in solution form, places might be found in the vast and deserted arctic areas of Canada, Greenland, northern Siberia or the Antarctic, and possibly in deserts and steppes. With the present-day type of fission products it is doubtful whether economic means of transport to such isolated places can be found, but this situation may disappear if fission products should later on be produced in much greater purity, *e.g.* from the gaseous discharge of homogeneous reactors.

Less drastic precautions would be required after the separation of Sr and Cs. The type of sandy strata which, at moderate depth, serves both domestic and industrial water supplies, becomes greatly compacted when at depth of more than 500 m. In these conditions there is practically no water flow. These sandy deposits usually have a substantial ion-exchange capacity and therefore would represent an ideal burial ground. The fission products of lowest adsorption, which diffuse fastest—such as Ru—have only a short life and, though able to diffuse, do not get very far in their short lifetime. On the other hand, the trivalent elements Pm and Sm, as well as Np and Am, which have a comparatively long life, are very strongly adsorbed and therefore would not move any significant distance within thousands of years.

Disposal of Sr and Cs

It is not likely that Sr or Cs would need to be disposed of until their activities have considerably decayed. These two materials can be of great value as sources of radiation. This is almost certain to be the case for the γ-radiating Cs. Even if the industrial utilisation of the β-radiation of Sr should not be practicable, the heat obtained from its decay would make it worth while to retain this material (which, owing to the absence of γ-radiation, requires little shielding), even if for heating purposes only.

After a substantial decay, when the specific activity of these elements would become too low for economical use, disposal may then be considered. As the quantities involved are quite

Table 1. Quantities of Fission Products Derived from 1 ton of U^{235}
(150 *days' irradiation*, 30 *days' cooling*)

Group	*Element*	*Kg*
0	Kr + Xe	128
1	Rb	15
	Cs	118
2	Sr	42
	Ba	43
3	Rare earths + Y	317
4	Zr	125
5	Nb	5
6	Mo	92
	Te	16
7	Tc	29
	I	7
8	Ru, Rh, Pd	61

Table 2. Example of F.P. Solution, Illustrating Concentration Problem

Total volume of solution	*Before concentration* 5-10,000 *cu. m.*	*After concentration* 25 *cu.m.*
Main constituents:	*Tons*	
HNO_3	1,300	10.5
$Fe(NO_3)_3$	6.8	
$Cr(NO_3)_3$	1.5	
$Al(NO_3)_3$	0.6	
$Ni(NO_3)_2$	0.5	
$UO_2(NO_3)_2$	1.3	
Mixed fission products (less gases) 870 Kg in nitrate form	1.8	

Table 3. Approximate Value of Some Fission Products

Element	*Kg./ton fission*	*Value (£/kg.)*	*Total value (£) for 20-ton programme*
Ru	38 kg.	380	288,000
Rh	16 kg.	680	220,000
Pd	7 kg.	125	17,000
Xe	13 cu.m.	£3,000/ cu.m.	780,000

small, one could then consider comparatively expensive treatment such as absorption in silica-bonded clays,[5] or in the naturally occurring montmorillonitic green-sands,[6] followed by baking at 1,000°C. (which leads to insoluble ceramic materials) and final disposal in safe areas. These green-sands have the advantage over the clays used by Ginell *et al.*[4] that they are suitable for column packing without special treatment, though they have a smaller ion-exchange capacity. For this kind of disposal, it is not necessary to have expensive heat-treatment apparatus. One can visualise burying the dried clays or green-sands, saturated with Sr or Cs, in water-impenetrable strata such as clays or gaults, under such conditions that the heat developed by radioactive decay raises the temperature above 1,000°C. Perring[7] has calculated that the diameter of the holes required for obtaining such temperatures is only a few feet, depending on the exchange capacity of the adsorbing material and the specific activity of the final product.

Recovery of valuable materials from old solutions

Among the fission products which are effectively inactive after 13 years, there are a number of elements of very high specific value, such as the metals ruthenium, rhodium and palladium and the rare gas xenon. Their approximate present-day value is shown in Table 3.

In addition to this, the old fission product solutions contain 29 kg. (per ton fission) of technetium, a long-lived element which does not occur in nature, and substantial quantities of neptunium and americium, which can be gainfully recovered. Indeed, the latter (mainly Am^{241}, $\tau = 470y$, $\alpha = 5.5$ MeV), though at present a comparatively unimportant contribution of radiation to the fission product solutions, will become a first-order radiation hazard of old solutions when, at the later stages of the nuclear energy programme, extensive recycling of Pu takes place.

At this future stage, the presence of americium in large quantities may well cause a bias against any disposal in the ground or at sea.

Xenon, which, with the present recycling processes, arises during the dissolving of the reactor elements in gaseous form, can easily be separated from the long-lived β-active krypton by a process of gas chromatography.[8] If produced in large quantity, its price is likely to fall, but even so it would be a useful by-product.

Choice of suitable scheme on economical grounds

Conditions may vary greatly from one country to another and, while it is not possible to consider all variations, a few possibilities will be discussed from an economical angle applicable to Great Britain.

Primary evaporation. The cost of the primary evaporation is by far the biggest item in the whole disposal process. McCullough[9] has estimated the cost of evaporation at about 10 cents/gal. processed and a somewhat smaller cost would apply in Britain. Assuming an initial volume of 5,000 cu.m./ton fission and an evaporating cost of £6 10s./cu.m. of original solution, the total evaporating cost of a 20-ton programme would be £650,000 p.a. As such a programme is equivalent to 60 million tons of coal produced, the evaporation cost is equivalent to 2½d./ton of coal-equivalent. This represents roughly 0.4% of the present-day value of coal. We can also roughly estimate the cost of subsequent operations and shall compare 'permanent storage' with 'separation-disposal scheme' on the basis of a 20-ton programme.

Tank storage. Tanks for the storage of 500 cu.m. p.a. would involve in Britain an annual construction cost of £50,000. Allowing another £10,000 p.a. for maintenance, administration and occasional replacement, an annual expenditure of £60,000 would have to be set aside.

If a tank becomes empty again after n years, then, allowing a discount rate of 4%, the actual cost p.a. is given by applying a factor of $[1 - (1.04)^{-n}]$, *i.e.* £24,000 p.a. for a storage period of 13 years.

Separation of Cs and Sr from highly active solutions. It is not possible at this stage to give a cost estimate of the separation process of cesium, in view of the uncertainties as regards the composition of future fuels which may require different processing and thus give a different raw material from which the cesium is to be extracted. In view of the complexity of this operation it is safe to say, however, that the cost of separation will be very much larger than the cost of the evaporation stage.

Separation of rare metals from old solutions. A useful method for separating both the rare metals and technetium could be based on electrolytic de-acidification combined with metal deposition. No details have been worked out for such a process, but in view of the fact that only little shielding would be required, the cost would be considerably less than the value of the rare metals, which latter is of the order of £250,000 p.a.

Separation of Am. This would probably require (*a*) de-acidification, (*b*) fluoride precipitation of rare earths and (*c*) column separation of Am from rare earths. In view of the high α-activity of Am^{241}, this is bound to be an expensive process and it is doubtful whether this would ever be economical.

Further economic considerations

In spite of the uncertainties in these assessments, it is clear that it is not possible to consider the economics of the disposal problem separately from fission product utilisation, as there are no economic advantages of any disposal scheme as compared with permanent storage for concentrated fission product solutions. The situation might be different if we had to deal with solutions, the electrolyte content of which is so high that little or no concentration is possible, and where the volumes are increased by a factor of 25 or more. Only in such cases may

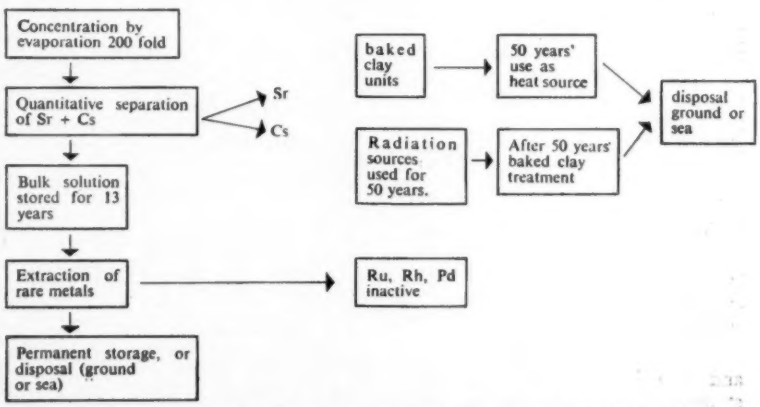

Concentration by evaporation 200 fold
Quantitative separation of Sr + Cs
Sr
Cs
Bulk solution stored for 13 years
Extraction of rare metals
Ru, Rh, Pd inactive
Permanent storage, or disposal (ground or sea)
baked clay units
50 years' use as heat source
Radiation sources used for 50 years.
After 50 years' baked clay treatment
disposal ground or sea

Fig. 3. Diagram showing a fission products disposal and utilisation scheme.

separation of the long-lived Cs and Sr, followed by limited storage and subsequent disposal, offer economic advantages by themselves. Otherwise, utilisation of the products has to be taken into account.

The recovery of Cs and its total utilisation could pay, however, not only for the separation but also for the concentration process. The recovery of Sr would pay only if utilisation for radiation purposes is feasible. However, its removal from the bulk solution is desirable, if the remaining bulk has a low Am-content, as this renders the bulk fission product solutions comparatively harmless after ageing.

The recovery of the rare metals Ru, Rh and Pd from old solutions is apparently a paying proposition and makes it worth while to retain the solutions after the removal of Cs and Sr sufficiently long to reach a low activity level. It would be much more costly to recover these materials, either at an earlier date or if Sr and Cs had been left in solution.

It is very doubtful whether the recovery of Am and Np will ever be an economical process unless they are required for special reasons. In a future age of Pu-reactors, their increasing presence in fission product solutions might well weight the balance between disposal and permanent storage completely in favour of the latter, except for fission products arising with exceptionally small bulk.

A well-balanced disposal and utilisation scheme which is likely to be economical and self-paying, and thus does not increase the cost of the power produced from nuclear energy, is outlined in Fig. 3.

No attempt has been made here to assess the value of a utilisation of the radiation energy from fission products while they are still present in the fuel elements, or the value of isolated species like Zr or Ce as source of extra-high intensity radiations. This is a field which should be treated separately under the subject of fission product utilisation. The separation of Cs and Sr comes under a different heading, because their removal from the bulk facilitates the process of disposal and at the same time reduces its cost.

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The foregoing article has also appeared in Atomics.

Recent Publications

Tank fittings. Publication No. 66 from Whessoe Ltd. has been designed as a short survey of the range of tank fittings which the company manufacture under licence from the Shand & Jurs Co., California.

Immersion heat exchanger. Control of an exothermic reaction is a problem that has long beset chemists, a problem intensified by the increasing size of glass chemical plant, since when the size of spherical vessels increases, the outside surface area available for cooling does not grow in proportion to the volume. The development department of Q.V.F. Ltd. investigating this problem considered the possibility of introducing heat-transfer elements inside the vessel and the firm has now produced a unit which greatly simplifies operation control, offering a means of heat transfer independent of the containing vessel walls. Q.V.F. have recently issued a leaflet describing and illustrating this unit.

Roller mills. An illustrated booklet from International Combustion Ltd. gives details of the Raymond roller mills, in which improvements are now embodied to meet new fineness specifications. A special feature of the Raymond roller mill is the pneumatic feed control. This is operated entirely by the suction in the machine, which changes as the load varies.

Engineering machinery. A departure from the style of previous issues marks the machinery sales sheet No. 19 from F. J. Edwards Ltd. Items for immediate delivery are dealt with in an attached supplement, while the leaflet itself is given over entirely to fresh approach and presentation, and features the F.J.E. machine centre which was opened in 1952 for the exhibition and demonstration of new and used machines. The company specialise in sheet-metal-working machines, presses, machine tools, woodworking machines and tin box machinery.

Steel tanks. A handsome, illustrated, 76-page brochure from Braithwaite & Co. Structural Ltd. illustrates many examples, some unusual, of the company's pressed-steel sectional tanks. The latter section of the brochure is devoted to a technical section containing a general specification for Braithwaite pressed-steel tanks as well as data relating to particular types of tanks and ancillary items.

Air conditioning and fume removal. Fume removal for rolling mills is one of the subjects dealt with by the Visco Engineering Co. Ltd. in a new illustrated pamphlet. Other subjects dealt with include fume removal for arc furnaces and deseaming processes; combined fume removal and dust collection for arc furnaces; heating, ventilating and air conditioning of buildings and crane-cab air conditioning.

Chemical Engineering Textbook

The second volume* of this important textbook proves a worthy successor to the high standards set by Vol. 1. The book deals with the unit operations, so that there is no great break with tradition, but the operations are arranged in sections according to the basic fundamentals involved. Whether this is entirely satisfactory is a matter of opinion, but it does have the advantage of grouping related topics in successive chapters.

The treatment of the individual subjects is very complete indeed, and benefits from the authors' refusal to deal with subjects which are as yet purely empiric. The discussion always leads the reader from principles to an introduction to design practice, and numerous worked examples are introduced to assist this process. To an interested non-expert, for example, the chapter on distillation appears to be the most satisfactory thing of its kind every written.

One question comes to mind—upon which the authors, as experienced teachers of chemical engineering, must have an opinion:

Why, when it is considered useful to include a selection of problems for solution by the student, are the numerical answers (at least) never given?

Apart from such matters, however, one can only applaud and welcome such a worthwhile text, which will prove of value to every chemical engineer. T. K. Ross

*'Chemical Engineering,' Vol. 2, by Prof. J. M. Coulson and J. F. Richardson. Permagon Press Ltd., 1955. Pp. 975, inc. index, 60s.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Sulphuric acid

Combustion of gases containing H_2S and nitrogen-hydrogen compounds to SO_2 and water vapour. The combustion is effected with a limited excess of air at >1,150°C. with formation of NO, and the combustion gases are then cooled immediately to avoid decomposition of NO. The cooled gases, without any addition of NO or HNO_3, are afterwards treated in a lead chamber, tower or other NO system to form sulphuric acid.—736,146, *A. Zieren* (*Germany*).

Centrifugal separators

The apparatus comprises a rotor having straight rotary vanes therewithin and disposed radially to the axis of rotation of the rotor. The vanes rotate at a speed different from that of the rotor, whereby to scrape the internal surface of the rotor and detach the deposits of the denser constituents forming thereon, the deposit being then ejected through a discharge passage.—736,454, *J. E. A. Graae* (*U.S.*).

Dust extractor

Dust-laden-gas filtering apparatus comprises units each containing filtering element(s) alternately used for filtering and cleaning, means for agitating the filtering element, a valve for controlling the flow of gas through the element, a motor for actuating the agitating means, a second motor for actuating the valve, and means for controlling the motors whereby the first motor is caused automatically to undergo a series of reciprocations between each actuation of the valve by the second motor.—736,535, *G.G. Engineering* (*London*) *Ltd., et al.*

Moulding presses

A multi-die-cavity moulding press, in which the bottom moulding tool contains the die cavities and the top moulding tool has punches (which move down to press and mould a composition in the cavities, and are then retracted), is provided with a loading tray reciprocated from a position below a charging hopper to a position over the die cavities. The tray includes a trailing extension which closes the hopper outlet when the tray moves towards the press, and the hole(s) of the loading plate are of adjustable capacity.—736,551, *British Industrial Plastics Ltd.*

Separation of mixtures

A slurry containing solid particulate material is treated to obtain fractions of differing solids content by directing a spirally-flowing slurry downwards in a confined space, the flow being divided at a point above the bottom of the space into a confined central flow and an annular flow, the former being discharged and the latter being continued to a lower level than that of the central flow discharge. The several rates of flow are maintained sufficiently high to maintain an open, central, free vortex flowing spirally downward. One fraction, containing the solids of lesser mass and/or density, is discharged through the central confined space, and the other fraction is discharged through a restricted port in the annular space.—736,313, *V. Rakowsky* (*U.S.*).

Weber process

Production of metals, *e.g.* Fe, Mn, Cu, etc., and town gas from coal and ore in briquettes. As the briquettes are passed through the furnace they are heated by means of a fine-grained heat carrier which flows in the same direction as the briquettes but passes down between them under gravity and is withdrawn, at points intermediate the furnace inlet and outlet, for reintroduction into the furnace at inlet points upstream of the flow of briquettes.—736,141, *Demag Akt.-Ges.* (*Germany*).

Production of CO and H_2 from methane, etc.

A hydrocarbon gas, *e.g.* methane, is mixed with a restricted amount of air or O_2 so that in a first step only partial oxidation of the hydrocarbon occurs, the mixture is contacted with a nickel- or cobalt-containing oxidation catalyst (preferably on a magnesite base) at an elevated temperature until nearly all the free O_2 is used up, and the resulting gas mixture is then contacted with a second catalyst containing iron (but no nickel) at an elevated temperature to complete the reaction between the gases from the first oxidation stage. Initial catalyst outlay is reduced and catalyst regeneration facilitated.—736,600, *H. Koppers Ges.* (*Germany*).

Drying chlorine

Moist chlorine is dried by cooling it to a temperature at which activated alumina is not attacked by it, bringing it into contact with activated alumina, and subsequently regenerating the alumina by submitting it to a current of cold air to remove the adsorbed chlorine, and then to a current of hot air.—736,666, *Soc. d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques d'Ugine* (*France*).

Fertiliser

Production of a soil regenerator or fertiliser by mixing the solid constituents of the contents of paunches of ruminants and of green vegetation (obtained by pressing the material) with phosphates, adding the liquid contents obtained from the paunches and green vegetation together with liquid manure and/or faecal matter to the solid mixture, thereby causing it to become heated, cooling the mixture to about 85 to 100°F., and inoculating it with microbic cultures selected from stocks which are fixers of nitrogen, oxidisers of ammonia, and cellulose ferments, and with chemical elements in a colloidal condition.—736,785, *H. Coanda* (*France*).

Feeding slurry, etc., to liquid

An apparatus (*e.g.* for feeding diatomaceous earth slurry to water in a filtration system) draws a quantity of slurry, etc., at separated intervals into a chamber by increasing the volume of the latter while an inlet valve is open. Between such intervals the valve is closed and the chamber is flushed out by valve-controlled admission and discharge of liquid from the main body to which the slurry is to be fed. All valves are positively and synchronously operated independently of pressure acting upon them.—736,895, *Wallace & Tiernan Inc.* (*U.S.*).

Heating and evaporating liquids

Liquids (especially acids and caustic liquors) are heated and evaporated in a simple apparatus wherein suction is applied to a container of the liquid (at above liquid level) to cause the combustion products from an inverted (bunsen) burner to be sucked down a tube which extends from just below the burner and into the liquid. The apparatus offers the possibility of preventing the fog formation which otherwise occurs.—736,909, *Farbenfabriken Bayer Akt.-Ges.* (*Germany*).

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in one of the attached postcards, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Kraft paper sacks carry chemicals

The long supremacy of the solid container (barrels, drums, tins, etc.) and jute and other fabric sacks as containers for chemical products is being effectively challenged by multiwall 'sacks' made of kraft paper, according to one manufacturer of multiwall sacks. Multiwall sacks have been used in the cement industry for many years past and, more recently, their suitability for use in the chemical industry has been recognised. They are a cheap, hygienic form of packaging, and safeguard their contents from impurities, mould and destructive pests, loss or gain of moisture and so on.

Multiwall *Palfsacks* are now being made of up to six plies, fitted together to form several sacks in one, each taking its share of the strain. Specially treated, impregnated and coated papers can be embodied in the sacks to guard against differing conditions so as to allow them to carry in safety moist, active or greasy commodities. For packing certain products, *Palfsacks* specially lined with polythene are available, the lining being inert, odourless, tasteless and non-toxic. To match the strength of the paper walls, sturdy closures and seams have been developed which give security, but allow ready closure and opening.

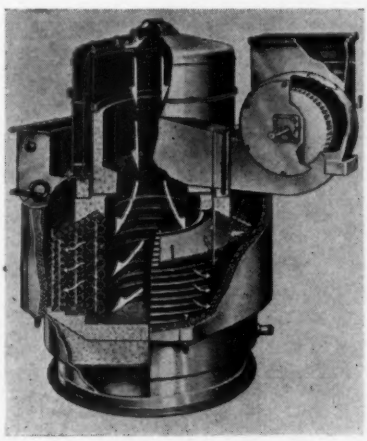
The sacks are specially designed to suit each individual purpose and, being low in cost, they are used only once and then discarded. Thus, the makers point out, any possibility of contamination, as is possible with the use of returnable jute and other fabric sacks, is avoided. It is further claimed that the use of kraft paper ensures against loss through percolation and, in addition, the cost of returning, cleaning and accounting for used sacks is eliminated.

The sacks can be printed with a manufacturer's full brand and trade names and advertising material, together with any necessary instructions for the consumer. The uniformly shaped sacks can be easily filled and readily handled and stacked, requiring very little storage space whether empty or full. Multiwall paper sacks can be used in place of other sacks, or in conjunction with them; this need not necessarily imply alteration of existing filling machines and practice.

CPE 147

A compact steam generator

A number of advantages are claimed for the *Vapor* steam generator, which is now to be constructed and marketed in Great Britain and Ireland; perhaps the greatest of these is fuel economy, since the generator makes steam only when and as needed. This is because the admission of fuel to the burner is automatically regulated to correspond with the demand and as determined by pre-set controls.



'Vapor' steam generator.

Another advantage claimed is saving in manpower: there is no need for an extensive warming-up period before regular working hours, thus dispensing with the need for early reporting, as the required head of steam can be raised in 2 min. There are no fires to bank up for the night and no need for weekend or holiday attendance. Low installation cost is another favourable factor, while the compactness and comparative lightness of the unit permits siting close to the point of actual steam consumption, with a consequent saving of piping and associated pipe losses.

In principal the *Vapor* steam generator is a compact, forced-circulation water-tube boiler with several sets of coils nested and connected in series to form a single coil. Feed water passes through the coil once only. It is not recirculated and there are no drums, headers or internal reservoirs. Fuel is admitted to the burner in the proportion required to heat the amount of water passing through the coil at any one moment and so generate a controlled steam pressure at the coil outlet.

Heat is released in the pressurised combustion chamber at a rate from 10 to 20 times greater than that of conventional boiler practice. High turbulence forces the hot gases to scrub the coil surfaces and wipe off any insulating film of relatively cool gas.

The combustion air is preheated in an air jacket surrounding the upper part of the fire pot. It is delivered under forced draft to the burner where it mixes with the atomised fuel oil. The hot combustion gases are driven down and across the nested coils,

which are staggered to ensure maximum contact. The fire is adjusted to evaporate about 90% of the feed water admitted to the coils. The unevaporated water travels at high speed, carrying scale-forming sludge into a steam separator. Here it settles to the sump, and steam of over 99% quality passes through the coil outlet. The thermal efficiency of the generator is from 78 to 82% throughout the whole modulating range.

Controls are provided to give protection against breakdown and abnormally high steam temperature due to low water flow.

The generator is supplied in a range of seven sizes, covering the following h.p. ratings: 18, 40, 65, 100, 120, 135 and 160. Where steam requirements exceed those of the largest unit, it is customary practice to install a battery of individual units totalling the required supply. **CPE 148**

Fire detector works on nuclear physics principle

The scientific application of nuclear physics to the problem of fire prevention has led to the development of the *Minerva* fire detector. In this system the sensitive element is an ionisation chamber in which the air is rendered conducting by the alpha particles emitted from a small quantity of radium compound having a theoretical life of 1,000 years. The entry of smoke or other products of combustion into the chamber radically changes the electrical characteristics of the ionised air. These changes call into action a balanced circuit, the output of which may be used to raise an alarm or to bring into action automatic fire-extinguishing equipment.

The heart of the balanced circuit is a cold cathode gas-filled tube, of original design, inoperative until triggered by the presence of smoke or other products of combustion in the ionisation chamber. Since no current flows through the valve while the system is on guard, there is nothing in the detector to wear out. As soon as the system has operated it can be immediately reset to come on guard again.

Minerva detectors, suitably sited about the building or built into the equipment to be protected, are connected to a combined control unit and signal panel. A display on the panel indicates the location at which the alarm originates, and from it a remote indication may be transmitted to a distant fire station or other convenient watch office. Each *Minerva* detector protects some 1,000 sq. ft. of floor area.

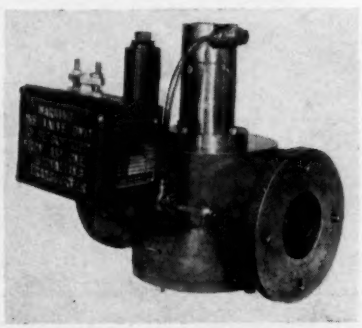
A typical installation consists of one or more detectors located in the areas to be protected, and a control unit which provides the necessary power supply. This unit also contains the alarm indicators and associated warning devices. The number and positions of the detectors vary with each installation and are established by a careful survey.

In general, the detectors are wired in groups using a two-wire system, following normal electrical installation practice. Each group is connected to a warning lamp on the control unit, which lights immediately smoke enters any one of the detectors in the group. At the same time audible warning is given by bells or klaxons suitably positioned in the building.

The control unit can readily be arranged to provide automatic alarm at a remote fire station or other convenient watch office and to operate CO_2, chlorobromethane or methyl bromide extinguishers, or sprinkler systems. **CPE 149**

Electrically operated valves

A range of intrinsically safe and flameproof valves manufactured by a British company is of interest to certain sections of the chemical and allied industries. One use of the intrinsically safe valve is in its application to the control of a 3-in. valve. It will be appreciated that direct solenoid actuation of the 3-in. valve would necessitate an extremely large solenoid compared to the solenoid of the more convenient pilot valve and, also, this control is achieved with a low electrical power consumption.



Intrinsically safe solenoid valve.

Both normally open and normally closed versions of the relay valve are available and any pressures between 10 to 100 p.s.i. can be controlled. Pilot valve pressures can be either within the relay valve pressure range or higher and of a different media.

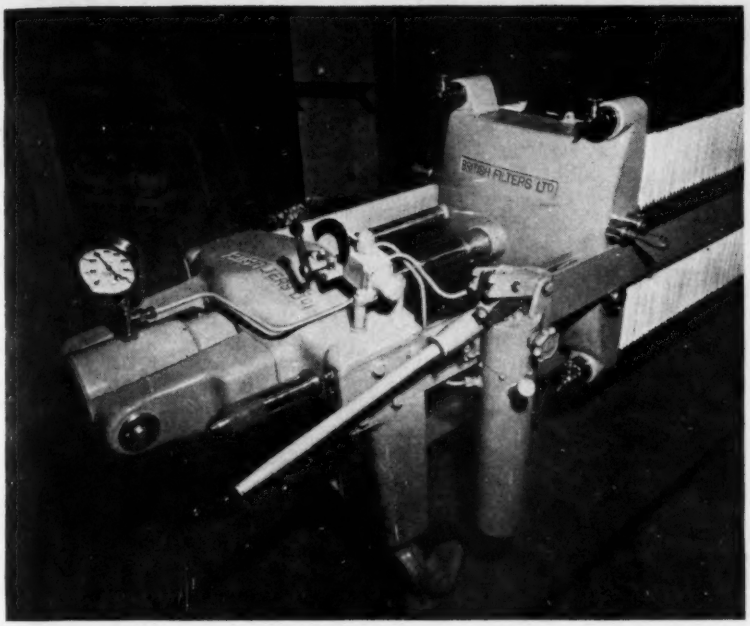
Two of many applications of such large valves are in the control of gas engines for pumping installations in the petroleum industry, and the control of vacuum suction pads for handling steel and fibrous material sheets.

The electrical characteristics of these valves are such that they absorb a maximum current of 0.45 amp. a.c. with a p.d. of 10 v. at the transformer output terminals when they are used in the mining industry. Where the valves are to be used industrially, the maximum current is reduced to 0.41 amp. a.c. with a p.d. of 9.5 v. at the transformer output terminals. **CPE 150**

EXPLOSION AND FLAME-PROOF ELECTRIC RADIATORS

For use in factories, laboratories, etc., where the presence of inflammable and explosive materials and gases prohibits normal methods of heating, flameproof models of a wide range of column- and panel-type oil-filled electric radiators are available. In accordance with the Buxton test this flameproof head is constructed of non-welded cast steel, and will not transmit any flame or spark. It is gas-tight and so will prevent any inflammable or explosive gases being ignited by the electric circuits. (The conduit to the electric heaters must be mechanically sound and the joints gas-tight.)

It is claimed that the introduction of the *Hurseal* flameproof head makes possible the space heating of special industrial projects where the rigid control of the upper limit of surface temperatures is a critical factor. An instance is given of the manufacture of cellulose products where the solid residue of the cellulose solutions has a danger point of 180°F. To meet such special circumstances, an electric oil-filled radiator can be produced which operates at a maximum surface temperature of 160°F. or such lower maximum surface temperature as safety requirements may specify. **CPE 151**



Hydraulic ram used for closing operation on filter press.

Hydraulic ram used in filter press closure unit

Manually operated thrust screws have been used for many years on all types of filter presses. The need to reduce labour costs and at the same time to increase the efficiency of the closing operation has led a British company to develop a hydraulic unit for this purpose.

The latest version of this unit incorporates a double-acting hydraulic ram, operated by a hand pump through a three-way control valve. A standard *Staffa* 30-ton high-pressure ram was fitted into the machine, together with a two-stage *Duo* pump and control valve.

The ram has a piston diameter of $4\frac{1}{4}$ in. and, when working at a maximum pressure of 6,000 p.s.i., will develop a thrust of 38 tons. The ram is of very robust construction, the cylinder being of cold-drawn seamless tube, which is honed to very close limits. The piston rod is of high-tensile steel, and the piston is fitted with heavy-duty hydraulic packings. The trunnion end fitting and neck ring cap are bored from a solid billet and are screwed to the cylinder tube. Suitable 'O' rings are used to form the necessary seals.

The hand pump, which is also of robust construction, is arranged so as to work at two separate pressures. It has an output of $4\frac{1}{2}$ cu. in. when working at a pressure of 500 p.s.i., and of 0.33 cu. in. when working at a pressure of 5,000 p.s.i. Set to work at the lower pressure, the ram can be rapidly extended until it begins to take up the load. At this point a collar is disengaged on the handle and this has the effect of putting the pump into 'low gear,' operating the ram at the higher pressure and the correspondingly lower speed.

Staffa hydraulic rams are available as follows:

(1) High-pressure rams for working pressures up to 5,000 p.s.i.; strokes up to 12 in.; nominal loads from 5 to 100 tons.

(2) Single-acting 'tubby' rams with strokes of 1 in. for pressures up to 5,000 p.s.i., and loads up to 100 tons.

(3) High-pressure hollow rams, of standard strokes, for working pressures up to 5,000 p.s.i.; capacities up to 80 tons.

(4) Low-pressure rams for working pressures up to 2,000 p.s.i.; strokes up to 36 in.; loads up to 40 tons.

A wide variety of standard end fittings are available for the piston rods and the cylinders. **CPE 152**

Heating furnaces

At the beginning of last year a British firm commenced manufacture of the Petro-Chem *Iso-Flow* furnace and, for the first time, petroleum and chemical industries in the sterling area were in a position to obtain this cylindrical-type heater without spending dollars. A progress report from the company says that technical problems associated with the manufacture of the furnaces have been satisfactorily solved. Recent orders include furnaces for heating reduced crude, process gas, asphalt mix, fuel oil, steam, hydrogen and hydrocarbon vapours.

The design of the furnace consists of a vertical cylindrical steel structure with an integral self-supporting stack. The inside of this cylindrical casing, lined with insulation and insulating refractory brick, forms the combustion chamber. A circle of vertical tubes placed adjacent to the cylindrical wall are equidistant from the flame burst of burners located in the floor of the furnace. Positive firing control is obtained through the use of multiple and directional burners.

A central re-radiating cone located at the upper end of the combustion chamber serves the dual purpose of effecting an even distribution of radiant heat and increasing the velocity of flue gas with decreasing temperature at the upper section of the furnace. Uniform radiant-heat-transfer rates are obtained by subjecting the heating surface nearest the flame burst to a controlled amount of radiant heat while the upper sections of the heating surface are subjected to varying proportions of direct radiant and secondary radiant heat. The re-radiating cone is the only satisfactory method of the many which have been explored to achieve this object.

All tubes are supported at the floor level as a column and guided at the top by removable segmental tube sheets eliminating horizontal tube stress, and it has been found that intermediate tube supports are seldom required. The design enables all parts of the furnace structure to expand vertically or circumferentially regardless of any temperature changes in the various sections. For maintenance or replacement, the tubes can be removed vertically by means of the monorail with which the stack is equipped.

The makers state that the design has proved extremely flexible and that the symmetrically arranged heating surface permits placing any number of tubes in parallel. In a multi-pass furnace, all sections can be absolutely

symmetrical, with exactly the same number of tubes and headers and the same relationship to walls and burners.

By using the directional type of burner, they can be set for a uniform rate of heat transfer throughout the full length of each heating element. By regulating the quantity of oil or gas to each burner or by making a simple adjustment in the angle of firing, the heat intensity at each segment of the tube circle may be controlled. This is extremely useful when arranging the layout of multi-duty heaters, where different products at different temperatures and pressures are passed through the same furnace. **CPE 153**

Industrial metal detectors

An industrial metal detector, employing a screened search-head technique which immunises it against outside electrical interferences, is claimed to be applicable to almost all cases where it is desired to locate metal particles in non-metallic media.

The equipment comprises two parts: the search head and the control unit. The product to be examined is passed, usually by means of a conveyor belt or chute, through the search-head aperture. The control unit houses the oscillator, the stabilised H.T. supply unit, the amplifier and the relay section. The stabilised H.T. supply unit is designed to withstand wide fluctuations in mains voltages.

When the equipment is switched on the oscillator generates a continuous signal which is passed to the search-head coil. This signal is then returned to the amplifier in the control unit. When metal is passed through the search-head coil there is an effect on the signal being sent out. This alteration in the signal is greatly amplified on its return to the control unit, and is made to operate a relay in the relay section. This relay in turn will operate an alarm bell or lamp and, if required, cut off the motor driving the conveyor. An automatic rejection or marker device can also be operated from the relay section.

The relay section is designed to ensure instant recovery from the effect of the passage of metal through the search-head coil. Thus, if a succession of metal particles is encountered, each particle will be individually indicated.

The search head of the standard model is constructed to customers' requirements. Its aperture dimensions are governed by the width of the conveyor band or chute around which it is installed and the height of the product to be examined. Setting up of the equipment is extremely simple, it being necessary only to obtain a given reading on the search-head meter. There are only two controls—both provided with covers. One of these is set at the time of installation, and needs no further attention for several months. The other control needs 'peaking' perhaps once a month. By an ingenious circuit arrangement the equipment can drift off its original setting for a considerable period without any noticeable loss of sensitivity. The standard model can be supplied on motorised conveyor systems designed and constructed to customers' specifications.

Another model, the SJM, originated as the result of requests from several manufacturers for a small, highly sensitive equipment which could be easily transported from one site to another. The SJM employs miniature valves and is claimed to be the most compact equipment of its type manufactured. The search head of this model has a circular aperture up to 3 in. in diameter. **CPE 154**

Styrenated 'Epikote' resin ester

Recent experimental work which was primarily an attempt to find a way, by means of styrenation, of reducing the high cost of producing conventional *Epikote* resin esters, showed that, in addition to achieving considerable savings in cost, styrenation also conferred improved technical properties.

As a direct result of this work, a new resin named *Scopon* 1130 has now been put into production. It is a copolymer of styrene and an *Epikote* resin ester. According to the makers, styrenation has resulted in an upgrading of the physical characteristics of the ester in the following respects:

(1) Resistance to gas checking.
(2) Retention of film properties under maintained high temperatures.
(3) Speed of set on air drying.
(4) Water resistance.

The resin is recommended for stoving and air-drying applications where particular resistance is required to chemical attack and where exceptional film toughness and adhesion are required. Washing machine finishes and top-quality primers are typical examples cited by the makers, who also state that stoving finishes based upon this new resin show good colour and colour retention. Air-drying finishes can be prepared to be touch dry within 20 to 30 min.

The new resin possesses a useful working compatibility with members of the *Scopol* range of styrenated alkyd resins. It is thought that this new surface-coating medium may find particular application as a modifying agent for these resins when it is desired to upgrade their chemical resistance or other physical properties.

In general, it is stated, *Scopon* 1130 provides films of high build and good mechanical properties. **CPE 156**

ELECTRIC HOISTS

Now available on the British market is a new range of electric hoists. The illustration shows the standard Munck hoist No. 221, which the makers believe to be among the lowest in price now on the market. This model covers a range of from 5 cwt. to 2 tons. Other sizes of hoists cover a complete range of from 2½ cwt. to 10 tons' lifting capacity.

A variety of lift heights and speeds is available to cater for the needs of practically every type of installation from a small workshop to a vast factory or warehouse.

The Munck hoist is of all-steel construction, enclosed in a steel housing, with the motor automatically engaging or releasing the brake. The gearbox, brake and electrical contacts are all enclosed in the housing. A rope guide ensures the rope winding correctly on the drum in spite of any carelessness on the part of the operator. The rope guide also actuates, automatically, a limit switch to prevent over-winding and over-lowering. **CPE 155**

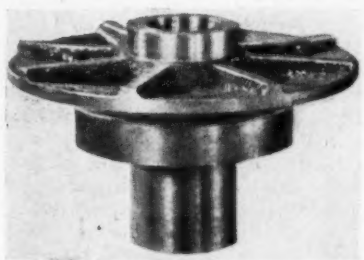
Pump without a stuffing box

A centrifugal pump with a hydrodynamic seal instead of a stuffing box is claimed to resist corrosion and abrasion when handling any of a great number of liquids. It is stated that it will operate with equal reliability at positive pressure and vacuum within very great temperature and pressure limits.

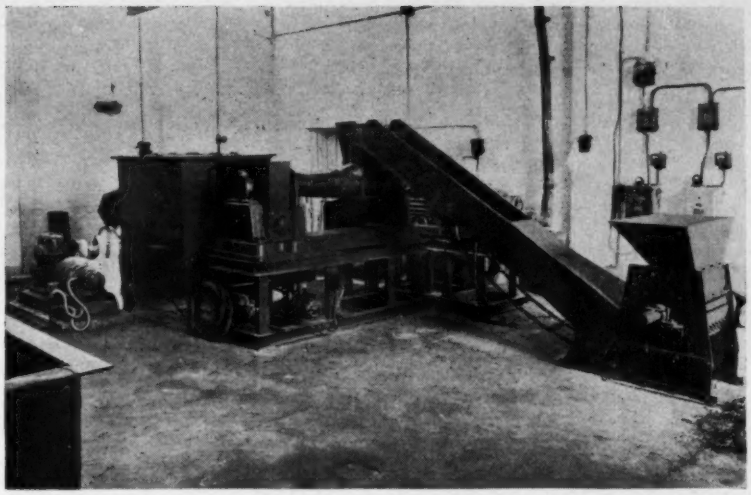
In the *Nobox* pump, which is of the vertical type, the liquid lock wheel is the major part of the design, and the sealing action, located at the suction side, occurs entirely hydro-dynamically. The upper vane ring of the wheel creates a liquid ring on rotation, which will seal against positive pressure and infiltration. The lower side of the vanes prevents air from coming in when the same pump is operating at vacuum or suction height. By proper balancing of the ratio between the diameters of the upper and lower vane ring, power consumption is reduced to a minimum. When the pump is out of operation, sealing is accomplished by a disc valve, which, however, during operation is completely disconnected and consequently is not subjected to any wear.

The pump is available in three standard series for varying ranges of capacity and head, but each pump is specially designed for its individual requirements, leaving margins for fluctuations in pressure, etc. The pumps can normally be obtained with a seal that is effective up to 24 in. Hg vacuum.

As one example of the applications of the *Nobox* pump, the case is cited of a works where it was used for injection of viscous black liquor into a steam boiler. It was in continuous use without any breakdown until nine years later, when the boiler was closed for renovations. **CPE 157**



Rotating liquid-sealing wheel used in 'Nobox' pump. The smooth flange under the lower impulsion flange gives an airtight seal even if the amount of sealing liquid in the sealed chamber should diminish.



Powling process: protein extraction plant. Raw material is fed into the hopper on the right, travels up the elevator and into the processing chamber housed in the tapered casing. Further stages include the washer, secondary processing chamber, receiving pit and settling tank.

Machine cuts de-watering and juice recovery costs

The Powling *Protess* machine, which has already attracted a good deal of attention from the agricultural industry as a means of extracting protein from vegetable waste, seems likely to find a number of applications in other industries for cutting down de-watering, drying and extraction costs.

For instance, it has already been used successfully and economically on a limited scale for extraction, without any pretreatment of the raw material, in the case of palm kernel, linseed, tung and coconut oils.

It is claimed that, by virtue of its design, the machine can do the same job as a conventional oil expeller, with less horsepower and therefore more cheaply. The machine is very robust, and tung nuts, for instance, can be fed to it whole instead of having to be 'de-bushed' before pressing.

Apart from oil extraction, etc., one interesting possibility offered by this machine is the pre-pressing of raw materials that are otherwise difficult and costly to dry. As an example of the de-watering capabilities of the Powling machine, hops have been reduced from a moisture contents of 92% down to 55 or 60%.

Heart of the process is a stoutly constructed, tapered worm gear inside a robust, tapered housing. The material fed into the machine is wormed along to the compression chamber at the narrow end. Here a solid gland is formed so that the liquid cannot progress any further and so returns through the oncoming material and out at the other end. The use of a compression chamber considerably reduces friction and thus results in a great saving of power as against the normal type of oil expeller. In addition, there are less 'foots' than in a normal expeller.

In the agricultural version of the machine, vegetable waste is fed into it and this is pressed by the tapering screw. The fibrous residue is given a second pressing, and the juice from both pressings is collected and precipitation is carried out to yield *Protess*, a product rich in protein and carbohydrates which is used as an animal foodstuff. It is claimed that *Protess* can be produced much more cheaply than fish meal and oil cake.

The industrial version of the Powling machine differs from the agricultural model, although the fundamental principle is the same. **CPE 158**

Soot blower packing

A special packing for soot blowers, *Cumpac* style No. 236, has recently been announced by an American firm. The packing is made of high-grade asbestos yarn braided over a plastic core of heat-resistant composition, then lubricated with mica. Or, if desired, it may be graphite-lubricated.

The design is a combination of lip-

type and solid packing arranged so that the solid part takes the gland pressure. This leaves the lips free to act upon the pipe or tube. Actuated by fluid pressure, the lips provide a tight seal with minimum friction.

The manufacturers report that this packing withstands high-pressure superheated steam without hardening, drying out or vulcanising during exposure to heat. The sturdy construction permits it to act as a bearing when needed. It is stated that, in installations where previously used packings lasted only a few weeks, the new packing is still in service after many months of operation.

The original *Cumpac* design has been thoroughly field tested for more than 10 years in a variety of applications. The new packing is an adaption of this design especially for soot blowers, and is supplied in a wide range of sizes. **CPE 159**

Tubes of two different metals resist inside and outside corrosion

Tubes which have different corrosion-resisting properties on the outside and inside are made by a British firm by carefully drawing a copper or brass tube outside or inside a mild-steel tube to form one single tube. In this way it is possible to select the metals most suited to resist each particular corrosion medium without reference to the other medium involved. For instance, in an ammonia condenser, brass tubes would not normally resist attack by the ammonia, whilst steel tubes corrode in the cooling water. Here the solution is steel outside and brass inside.

The tubes can be made in other metals as well, including copper and a special brand of aluminium brass. Bi-metal tubes can be composed of metals with widely different coefficients of thermal expansion.

Applications for these tubes exist in a wide variety of chemical and process engineering plant, for example: ammonia coolers and condensers; formaldehyde condensers, etc.; sugar evaporator tubes; oil refinery coolers and heat exchangers; coal-gas coolers and condensers; synthetic rubber production car-heating systems in diesel and electric locomotives.

The method of installation is similar to that employed with ordinary tubes, though, in some circumstances, special methods may be necessary to avoid galvanic corrosion at the exposed junction of the two constituent tubes.

The normal methods of installation are:

(1) Ferruling.
(2) Expanding.
(3) Expanding, using a ferrule of same composition as inner tube to reduced galvanic corrosion.

Where tubes are to be expanded they can be supplied end-annealed, but special precautions are then necessary during installation.

CPE 160

Synthetic rubber-based protective coatings

Three chemical-resistant coating materials have been announced recently by an American company. The first two are sold under the name *Neocor* and are based on neoprene synthetic rubber. *Neocor* HD is a series of thick, heavy-duty, chemical-resistant linings designed for severe process service. The members of this series are room-temperature-curing materials of the 'two-part' type and are supplied, therefore, in two containers, the first holding the vehicle and inert fillers and pigments, and the second the accelerator and vulcanising agents. When the contents of the containers are mixed and applied to the surface requiring protection, a tough, resilient, vulcanised film is formed.

The coatings may be applied by brush, spray, dip or roller, and tests have shown that one coat, applied by brushing on to a steel plate, gives a thickness of 0.028 in. *Neocor* HD linings are said to be serviceable over a temperature range –60 to 300°F., resistant to most alkalis and salts and all acids except oxidising acids at high concentrations. They are not, however, unaffected by aromatics, esters, ketones or chlorinated solvents.

The second coating, *Neocor* C10, is described as a room-temperature-curing, one-part, all-round-maintenance coating, available in various colours, and suitable for general fume, splash and weathering protection of, for example, structural steel, railings, outside tanks, catwalks and floors. For the latter purpose it may be combined with abrasive fillers to give non-skid properties. For application to metal, the latter is wire brushed or sand blasted and then one coat of *Neocor* primer P-25 is applied, followed by two coats of the coating material, allowing 3 to 4 hr. drying time between each coat.

The third protective coating, *Thiocor* JF, is a 100% polymerisable synthetic rubber. It is supplied in the form of a viscous liquid and, like *Neocor* HD, is a two-part type. When the vulcanising agent is added it cures to a tough, elastic form which remains flexible down to –65°F. It is unaffected by temperatures up to 250°F. in continuous service, and is capable of withstanding higher temperatures intermittently.

This material is not attacked by alcohols, aromatic or aliphatic solvents, refined or crude oils, jet fuels, or dilute acids and alkalis. *Thiocor* JF has been recommended for a wide variety of uses: for instance, as an expansion joint sealer for areas where jet aircraft are operating; as a protective lining for concrete storage tanks for petroleum and solvents; as an oil-resistant trowelled coating for steel surfaces; as a pourable, solvent-resistant gasket; and for use as a repair material for belting, hose and rubber rollers. It has good adhesion to metal, wood and concrete surfaces, and requires no primer coat, provided the surface in question has been prepared correctly. **CPE 162**

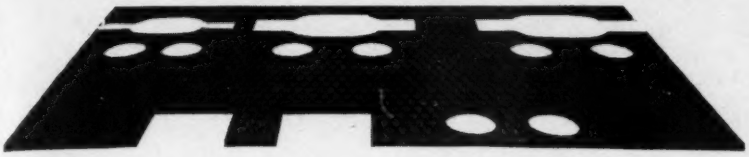
ORGANO TIN COMPOUNDS

A British firm has acquired the rights to make and sell a range of organo tin compounds that are made in the U.S. at present. These compounds are claimed to confer outstanding heat stability on PVC, making it possible to produce unplasticised compositions in the form of sheet and unmoulded sections. Such products are rapidly becoming of importance in industry as light structural materials, the high chemical resistance of which makes them particularly suitable for the manufacture of pipes and ducting.

The organo tin compounds are also used in plasticised formulations in the production of water-white transparent sheet and tubing.

The organo tin compounds manufactured under this agreement, together with metallic soaps, epoxide resins and organic phosphites, comprise the *Mellite* range of stabilisers. **CPE 161**

THIS STEEL FLOORING FITS ROUND PIPES AND VESSELS



An all-welded product fabricated from mild-steel strip, the sections of which vary according to the loading required, Safetread *steel flooring can be cut round any type of plant with a perfect fit however intricate the layout, the makers claim. It is suitable for all types of platforms, gangways and walkways, and it is stated that the welded construction makes it impossible for anything to work loose or cause chattering by vibration. It is also claimed that the flooring makes economies in supporting members possible.*

The flooring gives a non-skid surface over which wheeled vehicles can run as smoothly as over a solid floor and the mesh is so designed that workmen's tools, etc., cannot fall through. Another advantage with this mesh is that dust accumulation is avoided.

Safetread *armouring—a form of surface reinforcement designed to resist shock loads and to prevent concrete splitting—is also available.* **CPE 163**

Continuous processing with heat-transfer apparatus

The *Votator* heat-transfer apparatus, which has found wide application in the food industry, is claimed to be equally attractive for continuous processing in the chemical industry. Here the apparatus is designed for functions such as heating, cooling, emulsifying, mixing, aerating, extruding and flaking. Chemical processes involving polymerisation, sulphonation, sulphation, nitration, saponification, neutralisation and crystallisation can be carried out advantageously in this heat-transfer apparatus, according to the manufacturers.

Many chemical reactions can be carried out continuously in *Votator* apparatus. Turbulent agitation ensures intimate contacting of reactants and the highly efficient heat-transfer properties of the equipment permit close control of reaction rate. Shafts can be ported for multi-port injection of several feed streams. It is further claimed that *Votator* apparatus provides wide flexibility in choice of heat-transfer media, capacities and metals of construction, Units are available for use with a variety of heat-transfer mediums including ammonia, *Freon*, propane, ethylene, brine, water, steam and *Dowtherm*. Therefore, materials can be quickly heated—frequently beyond permissible limits imposed by batch methods—to more than 600°F. and cooled to temperatures lower than –100°F.

Depending upon the materials processed, overall heat-transfer coefficients obtained in *Votator* apparatus usually lie between 200 and 500 B.Th.U./hr./sq.ft./°F.; units are available having 0.7 to 60 sq. ft. of heat-transfer area. Capacities of single units range from less than 100 lb./hr. to over 30,000 lb./hr. Metals of construction may be carbon steel, nickel, stainless steels or special alloys as required by the nature of the materials processed. **CPE 164**

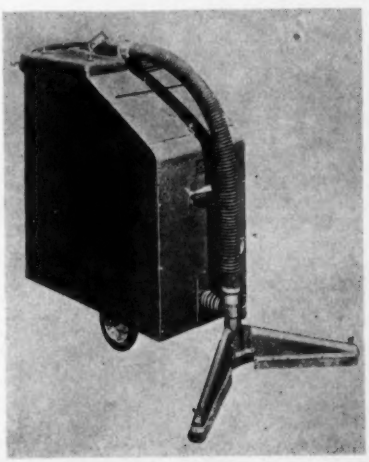
Chemical and industrial products	*Function of* Votator *apparatus*
Acetic anhydride	Crystallising
Chlorinated organics	Cooling and flaking
Cosmetics	Emulsifying and cooling
Drying oils	Control of reaction temperature
Gelatin and glue	Chilling and extruding
Industrial starch paste	Cooking and cooling
Lubricating grease	Heating, cooling, gelling and homogenising
Naphthalene	Cooling and crystallising
Paper coating	Cooking and cooling
Paradichlorobenzene	Crystallising
Petroleum polymers	Polymerising
Pharmaceutical gels	Cooling
Photo emulsion	Cooling, gelling and extruding
Printing ink	Heating and cooling
Resins (fluid)	Polymerising and cooling
Shaving cream	Cooling and plasticising
Soaps	Cooling and extruding
Sodium chlorate	Crystallising
Sulphonates and sulphates	Reacting
Textile print gums and sizes	Cooking and cooling
Viscose	Heating and cooling
Waxes	Crystallising, extruding and packaging
Wax emulsions	Mixing and cooling
Vinyl chlorides	Cooling and foaming

Vacuum cleaner idea

A firm who manufacture portable industrial vacuum cleaning plants announce a new development which, they claim, overcomes a weakness of industrial vacuum cleaners. It is an attachment for coupling to their model RM22 machine in a matter of seconds for large-area floor and gangway sweeping which can then be executed at a smart walking pace. Without interfering with production, dust and dirt are removed, and an adjustable slide incorporated in the tool allows the removal of the usual factory debris —all without raising any harmful dust.

The new attachment is said to be the only tool of its type in the world. It is made in three standard widths of 18, 24 and 30 in.

In many cases this attachment might obviate the need to install expensive, rotary-type floor sweepers, it is stated. **CPE 165**



'Chevron' attachment for industrial vacuum cleaner.

New idea in laboratory stirrers

In a new variable-speed laboratory stirrer that is being marketed, the volts on the armature are controlled by an auto-transformer with 10 tappings, whilst the field windings are supplied with a constant high voltage. This arrangement, according to the manufacturers, gives a range of very stable speeds with high torque at low speeds.

The stirrer is described as embodying the following features:

(*a*) Full 1/35th h.p.
(*b*) Ten speeds up to 7,000 r.p.m.
(*c*) High torque at low speeds.
(*d*) Speed stable under varying load.
(*e*) No resistance to get hot or burn out.
(*f*) Double-ended shaft.
(*g*) Sintered bronze bearings lubricated for life.
(*h*) Speed control can be away from dangerous reactions or outside the fume cupboard.
(*i*) Standard ½-in.-diam. support tube guides the power lead away from danger.

Price of the unit (less chuck) is £8 15s. The chuck, with ¼-in. collet, costs 13s. 6d. **CPE 166**

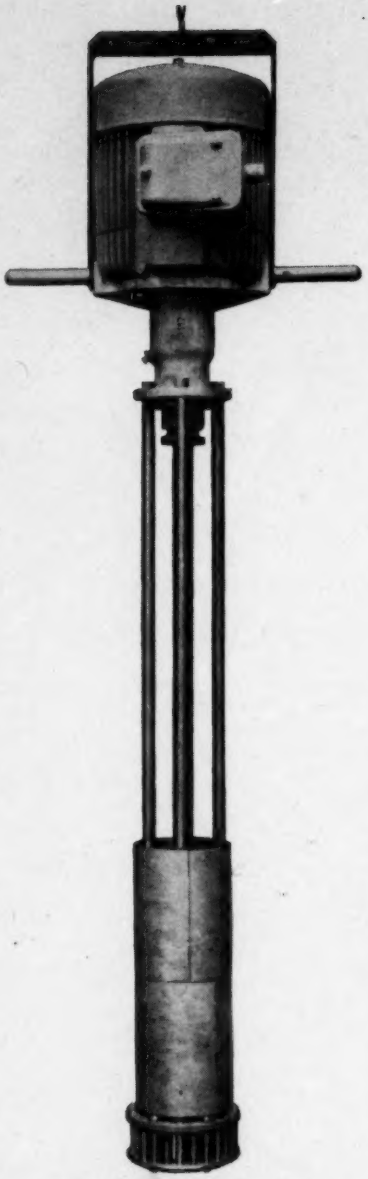
Two new evaporators

A new piece of apparatus is a rotary film evaporator, designed to evaporate heat-sensitive solutions down to small bulk batch quantities up to 350 ml.—such as solutions obtained by the Craig counter-current extraction technique and, in certain cases, by chromatography.

The apparatus operates under vacuum and rotates on rollers. The flask containing the original solution is heated in a water bath, while the receiver flask is cooled in a freezing mixture. Under these conditions, rapid concentration of the thermo-sensitive solution occurs.

Another development is a circulatory cyclone evaporator which, say the makers, has the advantage of rapid circulation and a small working volume (500 ml.). Heat is supplied by means of a coil through which steam is passed.

It is ideal for recovery of inflammable solvents or rapid evaporation under vacuum of heat-sensitive solutions. As the apparatus incorporates a cyclone, it is very effective in stopping entrainment of liquids or solids in the vapour phase. It is fitted with a tap adaptor at the bottom to enable stock liquid to be fed continuously to the evaporator while it is under vacuum. **CPE 167**



HIGH-SPEED MIXING

A new machine which is stated to have a simple construction incorporating a turbine diffuser and special design to make it suitable for a wide range of uses for dispersing solids in liquids, liquids in liquids, and gases in liquids. Known as the Ultramix *high-speed portable mixing and dispersing machine, it is stated to be adaptable to a variety of methods of mounting and, if required, is available in stainless steel.* **CPE 168**

Infra-red spectrometer

A new infra-red spectrometer is designed to operate in the region 1 to 4μ, with resolution of a very high order. Merton-NPL gratings are used as a dispersing agent and the detector may be either lead selenide or lead sulphide cells. The use of a fore prism is obviated by a system of crystal filters.

The instrument is extremely portable and the makers state that, with a peak resolution better than one wave number and an output stability when indicated on a Brown recorder of 1%, it has many applications in the analysis of organic liquids and gases.

A number of models are also working on the analysis of heavy water. **CPE 169**

Straining heavy slurries, etc.

The makers of a separator used for passing heavy slurries and viscous materials through very fine meshes are now offering a new and very much improved version, known as the *Streamline* model. The standard separator is quite a small unit measuring 5 ft. 7 in. long, 2 ft. 9½ in. wide and 44⅛ in. in height, the motivating force employed being a form of controlled gyratory vibration. The output capacity ranges from 1,000 to 15,000 gal./hr., according to the type of material in process. It frequently transpires that greater outputs than these are called for, but it would appear that the gyratory system employed will only operate efficiently in one particular critical size of unit, so that where larger outputs have to be dealt with a multiplicity of units must be installed, an arrangement which may not always be convenient.

The *Streamline* model has about double the capacity of output compared with the standard separator. Except that it is very slightly wider, the new machine has the same overall dimensions as the standard separator and, by an ingenious rearrangement of the porting, the operative screen area has been increased by 23%, at the same time maintaining the full gyratory force.

The unit is now mounted in a heavy box section frame, which has the effect of preventing the escape of the gyratory effects to the static part of the machine. **CPE 170**

★ Personal Paragraphs ★

★ Sharples Centrifuges Ltd. announce the appointment of **Mr. M. E. O'Keeffe Trowbridge** as a director of the company. He graduated in chemical engineering at London University and has had extensive experience in the chemical and chemical engineering industry in Europe and the U.S. He joined Sharples in 1953 and has been responsible for the company's technical, technical sales and project engineering activities. He will continue to have overall responsibility for these functions.

★ **Mr. A. R. Key** has been appointed vice-president of Johnson, Matthey & Co. Inc., the American associate of Johnson, Matthey & Co. Ltd. He joined the Birmingham branch of the parent company in April 1935 and remained there until October 1939, when he left to join the Army. In June 1946 he returned to Birmingham. In January 1952 he moved to the company's head office in Hatton Garden and later in the year made an extensive tour of the U.S. He was transferred to the staff of Johnson, Matthey & Co. Inc. in April 1953.

★ **Dr. G. L. J. Bailey** has been appointed superintendent of the platinum metals research laboratory of the Mond Nickel Co. Ltd. at Acton, London, in succession to **Dr. E. C. Rhodes.** He will take up his new duties on February 1.

★ **Mr. E. J. Bradbury** has been appointed assistant superintendent of Mond Nickel's development and research laboratory in Birmingham.

★ Sunvic Controls Ltd. have appointed **Mr. O. L. Welborn** as a general representative for the south-west area. **Mr. W. J. Donnelly** has been appointed technical representative for the Midlands area for their Scientific and Industrial Division.

★ **Mr. H. W. Francis** is chairman of the newly formed company, Newman Hender (Canada) Ltd., the Canadian subsidiary of Newman, Hender & Co. Ltd. The other members of the board are **Messrs. N. P. Newman, F. R. Newman, A. G. Burton** and **F. H. Caird. Mr. C. V. H. (Boysie) Bryan** is the vice-president and general manager of the company.

★ **Mr. P. W. Clepham,** general manager, has been appointed a director of St. Helens Cable & Rubber Co. Ltd.

★ **Mr. G. R. Blakely** has been appointed to the board of directors of G. A. Harvey & Co. (London) Ltd., as works director. He joined the company in 1952 as general works manager.

★ Following the recent formation of Square D Ltd., specialists in electrical control gear and switchgear, it is announced that **Mr. H. Dale Langley** has been appointed technical manager in the U.K., with ultimate responsibility for technical liaison with British manufacturers. The new company is an associate of the Square D Co. of America.

★ **Mr. J. C. Y. Baker** has been elected chairman of the Junior Institution of Engineers; **Mr. J. E. Gray** and **Mr. R. Whitehead** have been elected vice-chairmen.

★ The following elections and co-options were made at the November meeting of the A.B.C.M. Council to fill vacancies: *Elected members*—**Mr. D. J. Bird** (Fisons Ltd.), **Mr. E. Le Q. Herbert** (Shell Chemical Co. Ltd.) and **Mr. F. S. Poole** (Peter Spence & Sons Ltd.); *co-opted members*—**Mr. E. J. Bush** (W. J. Bush & Co. Ltd.), **Mr. G. H. W. Cullinan** (Shell Chemical Co. Ltd.), **Mr. R. S. Haskew** (The General Chemical & Pharmaceutical Co. Ltd.) and **Dr. J. E. Taylor** (Joseph Crosfield & Sons Ltd.).

★ **Sir Herbert Manzoni,** C.B.E., engineer and surveyor of the City of Birmingham since 1935, is the new chairman of the General Council of the British Standards Institution. **Sir Roger Duncalfe,** chairman of British Glues & Chemicals Ltd. and well known for his industrial and public services, was re-elected president of the B.S.I., and **Mr. John Ryan** (vice-chairman of the Metal Box Co. Ltd.) was elected vice-president on completion of his three-year period of service as chairman of the General Council. **Sir Stanley Rawson,** vice-chairman of John Brown & Co. Ltd., becomes chairman of the B.S.I. Engineering Divisional Council.

★ **Mr. J. L. Thompson,** of Chicago, is to manage in the U.K. the recently formed British subsidiary of the Square D Co., one of America's largest manufacturers of electrical control gear and switchgear.

★ **Sir Bernard Keen** has been appointed scientific advisor to Baird & Tatlock (London) Ltd. Until recently he was director of the East African Agriculture and Forestry Research Organisation.

★ **Mr. R. A. Henderson** and **Mr. J. L. E. Smith** have joined the board of the Solartron Electronic Group Ltd.

B.T.R. GROUP DINNER

A dinner was held in London by the British Tyre & Rubber Group recently, at which some 117 employees were presented with long-service awards by Sir Graham Hayman, chairman of the Group. Seen here on the first table, from left to right, are *(near side)* **Mr. A. E. Hughes, M.C., Mr. T. Hartley, Mr. P. W. Howard (managing director) and Dr. W. D. Scott; and** *(far side)* **Mr. S. G. Deaves, Cmdr. Sir Hugh T. Dawson, Bt., C.B.E., Sir Graham Hayman and Mr. C. I. R. Hutton.**

World News

GREAT BRITAIN

Nuclear energy means business

In 10 years nuclear engineering has so developed that it has become an important industry in its own right and by 1975 will involve business in the home market amounting to some £300 million p.a.

This forecast was made by Sir Christopher Hinton, managing director of the Industrial Group of the United Kingdom Atomic Energy Authority, speaking at the inaugural meeting of the British Nuclear Energy Conference. The conference has been formed by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institute of Physics and the Institution of Chemical Engineers.

Four lectures were delivered at the meeting by Sir John Cockcroft, K.C.B., director of the Atomic Energy Research Establishment, Harwell, and other well-known authorities.

PVC expansion scheme

The Solvic Group, one of the biggest producers of PVC in the world, in whom Imperial Chemical Industries Ltd. has an important interest, have embarked on a vast expansion scheme in a number of countries. In 1957, total production capacity of the group is expected to rise to 55,000 tons p.a.

In addition to their Belgian factory at Jemeppe-sur-Sambre, which has been expanded, new factories have been built in France, Italy, Austria, Spain and Brazil. Solvic manufacture various grades of polyvinyl chloride obtained by the emulsion and suspension process, and vinyl chloride/vinyl acetate copolymers and PVC compounds.

Doulton & Co. subsidiaries

An announcement from Doulton & Co. Ltd. states that, while overall control of their business will continue to be exercised by the managing director of the parent company, the four main production branches have been given separate identities and will operate as wholly owned subsidiaries.

The changes include, among others, the creation of a new subsidiary company, Doulton Industrial Porcelains Ltd., to control electrical porcelain, chemical and general stoneware, filters and a number of other industrial ceramics. Another new subsidiary company, Doulton Vitrified Pipes Ltd., will control drainage goods and conduits.

Elemental boron by the ton

After more than two years of intensive research, Borax Consolidated Ltd. are now offering amorphous elemental boron from pilot-scale production. A plant has been set up in California.

From the beginning of the company's research in this field, no difficulty was met in obtaining boron of 89 to 90% purity. Borax then set themselves the dual aim of developing a process which would consistently give a product of much higher quality, and at a price which would enable industry to investigate commercial applications for this interesting element. Process refinements took up most of the research phase, but both objects have now been attained.

Two grades of amorphous elemental boron are available, one of 90 to 92% and the other 95 to 97% purity. For ton lots, prices of the order of £5 to £6/lb. for the lower grade and £6 to £7 for the higher grade are envisaged.

Progress in plastics education

Grants totalling £3,500 had been made to students up to the end of November 1955, it is reported by the trustees of the Plastics Industry Education Fund.

Nuclear power station construction

The G.E.C.-Simon Carves Industrial Atomic Energy Group have come to an arrangement with the Motherwell Bridge & Engineering Co. Ltd. under which the latter company will be associated with them in the construction of nuclear power stations.

The Motherwell works cover an area of 35 acres and have a shop floor area of 410,000 sq. ft. Except for the shipbuilders the company is the largest buyer of steel plates in Great Britain. They have recently installed one of the largest stress-relieving furnaces of its kind in the country and a pickling plant which contains the most modern equipment.

Associated with the development of their pressure-vessel shops, they have built modern laboratories for carrying out *x*-ray development and viewing, and mechanical and metallurgical testing covering all the modern methods of steel process control. As part of their current £1-million works extension and re-equipment scheme, they are installing a 2,000-ton hydraulic press for special plate work to supplement their existing 1,000-ton press.

The company is closely associated with the Chicago Bridge & Iron Co. of America and a free interchange of technical developments and research takes place between the two companies. They are the sole licensees for *Hortonspheres* and they are at present constructing the 140-ft.-diam. sphere for the United Kingdom Atomic Energy Authority's experimental fast reactor at Dounreay.

New workshops for British Oxygen

A large extension for plant manufacture is now being built by the British Oxygen Engineering Co. at Edmonton. The new building will be completed very shortly and will be occupied in April. A rapid construction programme has been made possible by the adoption of building and construction methods already standardised by the company. The building has been designed by B.O.E.'s own staff of architects and civil engineers, who are also supervising its construction. Completion of the new plant buildings will complete a programme started in 1954 to centralise the British Oxygen Co.'s engineering and plant manufacturing activities at Edmonton.

Changes of address

Premier Colloid Mills Ltd., manufacturers of mixers and colloid mills, have moved from Belvedere, Kent, to larger premises at Hersham Trading Estate, Walton-on-Thames, Surrey (telephone: Walton-on-Thames 4246).

Shell Chemical Co. Ltd. announce that the address of their Midland sales office is now: Warwick Chambers, 14/20 Corporation Street, Birmingham 2 (telephone number unchanged).

The Sheffield office of Honeywell-Brown Ltd. has moved to larger premises at 119 Petre Street, Sheffield 4, and will be under the management of Mr. W. R. Owen.

Change of name

The name of the Vacuum Oil Co. Ltd. has been changed to Mobil Oil Co. Ltd.

IRAN

Abadan's cat cracker on stream

The catalytic cracker of the Abadan refinery, which was shut down for four years after completing its trial tests in 1951, was commissioned recently.

The overhauling of the cat cracker was carried out by a labour force of 300, with 30 Iranian engineers and assistant engineers helped by some foreign specialists.

FRANCE

Chemicals merger

A merger of three French chemical companies has been announced. The companies,Etablissements Barbet, Etablissements Egrot & Grange, both of Paris, and Ateliers Pingris & Mollet Fontaine, of Lille, have joined to form a new company to be called the Société Pour l'Equipement des Industries Chimiques. The new company will have a capital of 300 million francs.

Selling agents appointed

In a joint announcement, Hamer Valves Inc., Long Beach, California, and Joshua Hindle & Sons Ltd., of Leeds, England (licensed manufacturers of Hamer valves), disclose the appointment of Société d'Etudes Petrolières as exclusive selling agent for Hamer products in France and French possessions. Société d'Etudes Petrolières will also assist with representation and sale of Hamer products in Spain, Italy, Holland, Switzerland, Belgium, Luxemburg, Western Germany, Yugoslavia, Norway and Sweden.

JORDAN

Dead Sea potash deposits

It was recently announced that Egypt has agreed to take part in a £4,400,000 sterling project for exploitation of the potash deposits of the Dead Sea. The Jordan Government will subscribe £750,000 to the project, and the remainder will be offered for public subscription in the Arab countries. Any unsubscribed balance will be guaranteed by the Governments of the Arab states, cover being provided in stages over the three-year period required for the completion of the scheme.

Equipment will be bought in instalments.

WESTERN GERMANY

Iron ore processing

It is expected that the new plant being built at Salzgitter for smelting low-grade iron ore using the Krupp Renn Anlage process and which initially will have a production capacity of 180,000 tons p.a. of iron nodules to be processed into pig iron is to go into production in the autumn of 1956. According to a Board of Trade report from London, the project is costing some D.M. 35 million and is being financed by a group of Ruhr steel firms, including the Thyssen, Dortmund-Horde, Phoenix Rhein-Ruhr, Klockner and Mannesmann concerns, who have combined to form a new undertaking—the Salzgitter-Ruhr GmbH.—to operate the plant. West German domestic supplies of iron ore consist predominently of low-grade ores and this new plant, which is in part an experiment, may permit them to be smelted on an economic basis.

The Leonard Hill Technical Group—January

Articles appearing in some of our associate journals this month include:

Paint Manufacture—Manufacturing for Export; Meeting the Needs of Overseas Trade; World Paint Production; The State of British Trade; Oilbound Water Paints; Conditions in the Tropics; Supplying the World's Shipping.

Manufacturing Chemist—Hairwaving Chemistry; Pharmaceutical Flavours; International Process Licensing; Fine Chemicals for Medical Use; Progress Reports: Analytical Chemistry, Cosmetic and Toilet Preparations, Fertilisers and Plant Nutrients.

Food Manufacture—The Vacuum Contact Plate Method of Fruit Dehydration; Recent Advances in Starch Chemistry and Manufacture, 2; The Touch of the Dutch: A Food Technologist Visits the Netherlands; Meat Products for the Mass Market; Italian Food Engineering; Research in Low-cost Foods.

Petroleum—Sulphur from Petroleum; Teaching Petroleum Technology at the College of Aeronautics; Copper Tube Drawing in Britain.

Atomics—Positron Electron Annihilation and Positronium; A Remote Vacuum-operated Pipette Controller; The Elastic and Inelastic Scattering of Fast Neutrons, 1; Nuclear Reactor Control Systems.

World Crops—Report on the 1955 Smithfield Show; Agricultural Developments in St. Helena; The State of Agriculture in Israel.

Dairy Engineering—Linings for Mild-steel Tanks; How to Cut Steam-raising Costs; Dairy Industry in Israel; Cheeses of Great Britain; Liverpool—Last Stronghold of Town Cowkeepers; Getting Eight Pints from the Gallon: The Problems of Milk Measurement.

Muck Shifter—River Great Ouse Flood Protection Scheme; Drawing Off Ground Water by Electro-Osmosis; Explosives for Precision Work; Neath Bridge for South Wales Bypass.

Building Materials—Salt Glaze Ware for Drainage; Fibre Board for Thermal Insulation.

Corrosion Technology—Anti-Corrosive Applications of *Epikote* Resins; Corrosion Work by British Railways Research Department; Economic Cathodic Protection; Basic Studies in the Oxidation of Natural Graphites.

Fibres—Economic Harvesting and Preparation of Soft Fibres; Despatch by Rail; A New Tension Presser for Rayon Fabrics.

SOUTH AFRICA

Lime company's expansion

Two additional kilns came into operation last April at the works of the Union Lime Co. Ltd., and completed about half of the company's expansion programme. Over and above this project, it is now planned to spend £340,000 on extensions.

RHODESIA

Superphosphate manufacture

An announcement issued in London states that African Explosives & Chemical Industries Ltd., through their associated Rhodesian company, A.E. & C.I. (Rhodesia) Ltd., are to establish superphosphate manufacture at Rodia factory, near Salisbury. Plans have now been completed and construction of the plant will start in the immediate future. A.E. & C.I. (Rhodesia) Ltd. will continue the manufacture of compound fertilisers, and a granulation plant is also being installed at Rodia factory so that fertiliser products will be produced there in both powder and granular form. These plant extensions, which it is hoped will be completed by about 1958, will represent a capital investment of over £3 million.

Superphosphate has hitherto been imported from the Union of South Africa and from overseas, but the new plant in Rhodesia will have an initial capacity sufficient to meet the full requirements of superphosphate (both single- and triple-super) for fertiliser purposes, in the territories comprising the Central African Federation, for some years ahead.

The superphosphate project includes both phosphoric acid and sulphuric acid plants. The sulphuric acid plant will use pyrites mined in Southern Rhodesia as its raw material. It is hoped that these developments in the chemical field will help to promote other industrial development in the Central African Federation.

The two parent companies behind A.E. & C.I. in this venture are De Beers Consolidated Mines Ltd. and Imperial Chemical Industries Ltd. The decision to proceed with this major capital expansion scheme demonstrates their confidence in the future of the Federation.

BURMA

Russian coal experts' visit

Two Russian coal experts sent to Burma under the United Nations' technical programme will advise on the upgrading and utilisation of Burmese coal.

CANADA

Big new sulphur plant

It was recently reported that the Canadian Gulf Oil Co. had 'finalised' plans for a 225-ton/day sulphur plant at its big Pincher Creek gas field, approximately 50 miles south-west of Lethbridge, Alberta. The new sulphur plant will be Canada's largest. Construction work is scheduled for completion by September 1956.

The sulphur content of the Pincher Creek gas is high. Plans are to recover 225 tons of sulphur and 1,900 bbl. of condensate daily from processing 55 million cu. ft. of gas.

Pending completion of the trans-Canada gas pipeline, which will provide a large-scale outlet for the gas, the processed gas will be returned to the reservoir. According to Canadian Gulf—a subsidiary of Gulf Oil Corporation—a contract for delivery of elemental sulphur in a liquid state has been signed with Northwest Nitro Chemicals Ltd. The contract calls for a substantial part of Canadian Gulf's sulphur output. Northwest Nitro Chemicals will use the sulphur in processing of high-analysis nitrogen and phosphate chemical fertilisers at its new Medicine Hat, Alta., plant now under construction.

Aluminium extrusion

A $500,000 aluminium extrusion plant is to be set up near Vancouver by Pacific Coast Aluminium Ltd., a new company. Production of extruded bars and tubing is scheduled to begin next May. Raw material will be drawn from Aluminium Co. of Canada's Kitimat smelter.

INDIA

Synthetic rubber project

It was recently announced that the Government of India is seriously considering the establishment of a synthetic rubber plant to bridge the gap between the country's estimated future requirements and potential production of natural rubber. It was, however, emphasised that the project is still very much in the embryo stage. A report from the Board of Trade, London, points out that, according to the second five-year plan, about 40,000 tons of rubber will be needed by 1960, while natural rubber production will only amount to 26,000 tons.

The suggestion has brought forth considerable opposition from the rubber planters, who propose bringing a further 70,000 acres of land under cultivation, and improved methods of production, during the next 10 years. They claim that the interim gap between production and requirements should be met by imports, which they maintain would be preferable, in view of the drain on exchange resources caused by the import of machinery and raw materials for a synthetic plant.

NORWAY

Oil refinery plans

The Norwegian oil company, Norsk Esso, has been negotiating with the Government about the construction of a big new oil refinery. The capacity of the present refinery at Vallö is only 100,000 tons. The Oslo newspaper, *Aftenposten*, discussing the tentative plans recently, predicted that the capacity of the new plant would probably be at least 1½ million tons p.a.

Paper concern's investment programme

The Norwegian paper concern, A/S Union Co., has announced a £4½-million investment programme to increase production. It is planned to install a new paper plant at Skien at a cost of between £2 million and £2½ million. The plant will have an output of 45,000 tons p.a. of paper.

The company also plans to develop three waterfalls to augment its supply of electric power.

SPAIN

Industrial projects

Siderurgica de Ponferrada are reported to be installing new mining plant to extract 300,000 tons of iron ore p.a. They will require more machinery at a later stage in order to double this output.

The firm of Rodriguez Herrera & Co. has been authorised to construct a factory in Cieza (Murcia) for the production of 75,000 tons of Portland cement annually.

Sociedad Financiera y Minera have been authorised to enlarge their Portland cement factory in Malaga. The authority includes permission to import such material as cannot be supplied from national sources.

BRAZIL

Alkalis factory

The Cia Nacional de Alcalis, which is putting up a factory near Cabo Frio, a little to the north of Rio, on a loan worth the equivalent of U.S. $15 million granted by French interests, has announced that it will go into production by mid-1956. The company plans to produce 100,000 metric tons of sodium carbonate p.a., of which just under 30,000 tons will be transformed into caustic soda. Other products will be soda ash, lime, gypsum and calcium carbonate.

AUSTRALIA

Chemical industry's progress

Big increases in Australian capacity have provided adequate supplies of caustic soda and of cement (except in Victoria). It is still necessary to import some soda ash, but capacity to come into operation early this year should replace this. Similarly, ammonium sulphate, now in ample supply largely because of imports, will be fully provided from local sources when the new plant at Risdon, Tasmania, comes into operation.

This is reported in a survey issued by the Department of National Development, which also states that the supply of plastics materials, paint bases and lesser chemicals is adequate, and big increases in Australian capacity (particularly of PVC, polystyrene and titanium dioxide) will add to future supplies.

YUGOSLAVIA

New blast furnace for iron works

The second blast furnace of the Zenica iron works, in Yugoslavia, has begun operation, Tanjug, the Yugoslav news agency, has reported.

The furnace has a capacity of 600 tons/day of crude iron. The yearly output of the Zenica works will now increase to 400,000 tons and Yugoslavia's overall crude iron production will reach 700,000 tons.

Over $200 million (62,000 million dinars) have so far been invested in the new parts of the Zenica works.

VENEZUELA

New oil refinery projects

Two major projects, involving a total expenditure of nearly £15 million, have just been put in hand by the Cia. Shell de Venezuela.

The first, estimated to cost £7½ million, is the construction of a 20-in.-diam. gas pipeline running between the La Paz oilfield in the Maracaibo district of the State of Zulia and Cardon refinery on the Paraguana peninsula. Totalling 177 miles in length, it will be able to carry up to 106 million cu.ft./day of gas.

Delivery of the pipe will begin early this year and the line is expected to come into operation in 1957. The gas will be used as the principal fuel in the refinery's furnaces. A significant advantage that will arise from this will be the economic use of the natural gas which is produced with crude oil. Furthermore, additional fuel oil, which might otherwise have to be used in the furnaces, will become available for the export markets.

The second project, which is ex-

UNDERGROUND WORKSHOP AT WHITEHAVEN

Anhydrite for the Solway sulphuric acid and cement plant at Whitehaven is mined beneath the plant, in workings which extend under the sea bed. After blasting, electric shovels load the loose material into diesel dumpers, after which it passes to a hopper and thence via conveyor to the surface plant. This recent picture shows the underground workshop, with a dismantled electric shovel in the foreground.

pected to cost some £7½ million, is the construction of a fourth distillation unit at Cardon refinery. The new distiller, which will be in addition to the catalytic cracking and alkylation units now under construction, will have an intake capacity of about 4 million tons a year and its completion will raise Cardon's annual capacity to some 12¾ million tons.

SWEDEN

Iron ore mining

The Grangesberg Co. proposes to resume shortly iron ore mining at the Strassa mine, which has been closed down since 1923. The ore deposits are the largest in central Sweden apart from those in the Grangesberg area. It is planned to extend the capacity of the mine to 430,000 tons of concentrates with an iron content of about 70%.

The Swedish Government is to take over the Grangesberg Co.'s interests in the Luossavaara-Kirunavaara Mining Co. on September 30, 1957 (as a result of which the latter will then be wholly state-owned) for a sum of nearly Kr. 1,000 million, to be paid in five annual instalments from that date.

During the first eight months of last year 11 million tons of iron ore were mined in Sweden, compared with 9.9 million tons during the same period of 1954. Exports totalled 9.8 million tons during January-August 1955, compared with 9 million tons in the first eight months of 1954.

SWITZERLAND

Sugar refinery proposal

A Swiss Government-sponsored study group, which has been investigating the country's sugar supply situtation, has proposed the erection of a second sugar refinery. The new refinery, which is to work in close co-operation with the existing plant, Zuckerfabrik & Raffinerie, Aarberg A.G., is to be set up in the Canton of Zurich, the study group recommends. It is to be capable of processing 1,600 tons/day of sugar beet and, during peak periods, will employ a labour force of 300 to 400 workers. Construction costs are estimated at 42 million Swiss francs.

The building of the new refinery would make it possible to increase the area under sugar beet in Switzerland from the present 5,900 hectares to 10,000, so that about 25% of present needs could be met from domestic production as compared with 16% up to now.

The project is at present under consideration by the Cantonal authorities.

UNITED STATES

Formaldehyde project

The Chemical Division of the Borden Co. is to double its west coast output of formaldehyde by building a new plant in the Seattle, Washington, area. The new unit, which is planned to produce more than 36 million lb. of formaldehyde p.a., is scheduled for completion late this year.

The company said that the expansion was necessitated by new demand beyond the capacity of its Springfield, Oregon, plant. This reflected the accelerated needs of north-west Pacific industries using formaldehyde. With the Seattle plant supplementing the Springfield plant's output, a company official noted, Borden would be in a position to serve the entire area from western Canada to San Francisco Bay.

At present, the firm manufactures and sells about 10% of all the formaldehyde used in the U.S.

Pulp and paper plant

Marathon Corporation, of Wisconsin, is planning to build a $30-million pulp and paper plant in western Alabama. Primary consideration is being given to the construction of an integrated pulp, paper and hardboard mill on a 1,400-acre site and plans include the purchase of a 50-mile railway to link up with the main railway lines.

Electric generators for high temperatures

The Bendix Aviation Corporation has announced that it has designed electric generators for jet aircraft that can keep functioning perfectly at exceptionally high temperatures. Besides operating at internal temperatures up to 400°, the new units can produce their full rated output at altitudes ranging from sea level to 65,000 ft.

The largest generator in the new series is about the size of a 5-gal. jug and is designed for experimental planes. Parts are made of glass laminates, silicones, mica and similar material, and electrical connections are brazed with a silver solder.

Award for chemists and chemical engineers

Establishment of an annual award of $1,000 and a medal for outstanding achievement in industrial and engineering chemistry was announced at the 128th national meeting of the American Chemical Society.

The award, to be given by the Esso Research & Engineering Co. (formerly the Standard Oil Development Co.), will be known as 'The American

Chemical Society Award in Industrial and Engineering Chemistry, Sponsored by the Esso Research and Engineering Co.'

The purpose of the prize is 'to stimulate fundamental research in industrial and engineering chemistry and in the development and application of chemical engineering principles to industrial processes.'

Goodyear expansion plans

The Goodyear Tire & Rubber Co. has announced that it will spend $3\frac{1}{2}$ million to increase the capacity of its local chemi-gum and resin factory and $2\frac{1}{2}$ to raise the capacity of the local airfoam factory.

These are new items in the two-year $100-million programme of factory expansion now partly completed.

Carbon black plans

Plans for the construction of a new unit at Borger, Texas, that will increase furnace black production by 15% have been completed by J. M. Huber Corporation. The new unit will have an output of 20 to 30 million lb. p.a. of black, depending on the grade produced. This is the second recent expansion of Huber's furnace black facilities at Borger.

Fertiliser project for Japan

Chemical Construction Corporation has been named by Nihon Gas Kagaku Kogyo K.K., of Tokyo, Japan to design an important nitrogenous fertiliser project which will include a 100-ton/day ammonia plant and 90-ton/day urea plant.

The urea plant will incorporate Chemico's full recycle process, while the ammonia plant will be based on high-pressure reforming of natural gas.

New plastics material

Celanese Corporation of America is inaugurating large-scale production of cellulose propionate plastic at its Belvidere, New Jersey, plant. Celanese is the first U.S. producer of the material, which will be marketed under the name *Forticel*. It is described as a free-flowing thermoplastic material with a short moulding cycle, dimensionally stable, good form retention, surface hardness without brittleness, odourless and available in many colours.

SEASONAL GREETINGS

The staff of CHEMICAL & PROCESS ENGINEERING thank all those who sent Christmas cards and other tokens, and warmly reciprocate their greetings.

MEETINGS

Institution of Chemical Engineers

January 10. 'Explosions and Poisons—A Comparison of American and British Precautions,' by J. H. F. Smith, 5.30 p.m., the Geological Society, Burlington House, W.1. Joint meeting with the Chemical Engineering Group, Society of Chemical Industry.

February 4. 'Practical Aspects of Electrostatic Precipitator Operation—Experiments on Pilot Plant,' by A. Little, 3 p.m., the Midlands Institute, Birmingham.

February 7. 'Liquid Atomisation and the Drop Size of Sprays,' by R. P. Fraser and P. Eisenklam, 5.30 p.m., the Geological Society, Burlington House, W.1.

February 8. 'A Statistical Approach to Catalyst Development,' by N. L. Franklin, P. H. Pinchbeck and F. Popper, 7. p.m., the University, Leeds.

Society of Chemical Industry (Chemical Engineering Group)

January 25. 'Control of Corrosion in the Heavy Chemical Industry,' by D. R. Himsworth and W. D. Clark, 6.30 p.m., King's College, London. Joint meeting with Corrosion Group and the Institution of Chemical Engineers.

Institution of Mechanical Engineers

January 16. 'Advanced Courses for Engineers in Industry,' by W. Jackson, H. D. Morgan and Prof. G. F. Mucklow, 5.30 p.m., 1 Birdcage Walk, Westminster, S.W.1.

The Fertiliser Society

January 12. 'The Effect of Sampling on Fertiliser Analysis,' by E. W. Schwehr, 2.30 p.m., the Geological Society, Burlington House, Piccadilly, London, W.1.

Incorporated Plant Engineers

January 10. 'Materials Handling,' by J. Findlay, 7 p.m., 25 Charlotte Square, Edinburgh.

January 12. 'Some Factors Concerning Works Capital Expenditure,' by F. Franklin, 7 p.m., Scottish Building Centre, 425-427 Sauchiehall Street, Glasgow.

January 26. 'Some Aspects of Heat Transfer,' by C. S. Parry, 7.15 p.m., Grosvenor Hotel, Chester.

Junior Institution of Engineers

January 20. 'Some Notes on the Flow of Plastic Solids,' by R. F. Twist, 7 p.m., Pepys House, 13 Rochester Row, S.W.1.

Institute of Physics

January 13. 'Physics and Engineering,' by Dr. R. W. Sillars, Manchester.

Institute of Fuel

January 20. 'Modern Gas Production,' by J. E. Tulley and D. J. A. Mansell, 7 p.m., Royal Technical College, Glasgow.

January 26. 'The Occurrence, Extraction and Properties of Germanium,' by A. R. Powell, 6 p.m., James Watt Institute, Great Charles Street, Birmingham.

February 1. 'The Harnessing of Nuclear Power for Industry,' by J. L. Gillams, 5.30 p.m., the Institution of Civil Engineers, Great George Street, S.W.1.

New 'F.B.I. Register'

The latest edition of this directory* lists the products and services of over 7,000 F.B.I. member firms under more than 5,000 alphabetical headings. A feature is the French, German and Spanish glossaries, which give translations of every product term used in the main buyers' guide, each being numbered for easy reference between the English headings and their translations.

Other sections include a complete alphabetical directory of F.B.I. member firms listing their full names, addresses, range of products or services, etc., and in many cases additional information such as branch offices, overseas agents, subsidiary companies, etc.; particulars of approximately 300 trade and industrial associations affiliated to the F.B.I.; brands and trade names, etc.

*'F.B.I. Register of British Manufacturers, 1956,' 28th Edition. Published for the Federation of British Industries by Kelly's Directories Ltd., 1955. Pp. 1,110, 42s.

Glycerine. Standards for five grades of glycerine have recently been issued in one volume by the British Standards Institution. They cover, respectively, soap lye crude glycerine, saponification (hydrolyser) crude glycerine, pale straw glycerine, dynamite glycerine and chemically pure glycerine (glycerin). Specification requirements are given in respect of each grade, together with methods of sampling and of analysis of the materials. Some further methods of test, additional to those required for determining compliance with the British Standard, are also given in an appendix. (B.S. 2621-5 : 1955, 'Glycerine (Glycerol),' 10s.)